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ABSTRACT

This motorcycle repair curriculum guide contains the following ten areas of study: brake systems, clutches, constant mesh transmissions, final drives, suspension, mechanical starting mechanisms, electrical systems, fuel systems, lubrication systems, and overhead camshafts. Each area consists of one or more units of instruction. Each instructional unit includes some or all of the following components: performance objectives, suggested activities for teacher and students, information sheets, assignment sheets, job sheets, visual aids, tests, and answers to the test. Units are planned for more than one lesson or class period of instruction. Full-page illustrations and diagrams are presented throughout the guide. A list of the recommended tools and equipment necessary to complete the jobs required in the instructional units and an alphabetized list of publications used in completing the guide are also included. (BM)

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ED146394

# MOTORCYCLE REPAIR

by
Jim Hein
and
Mike Bundy

U S DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

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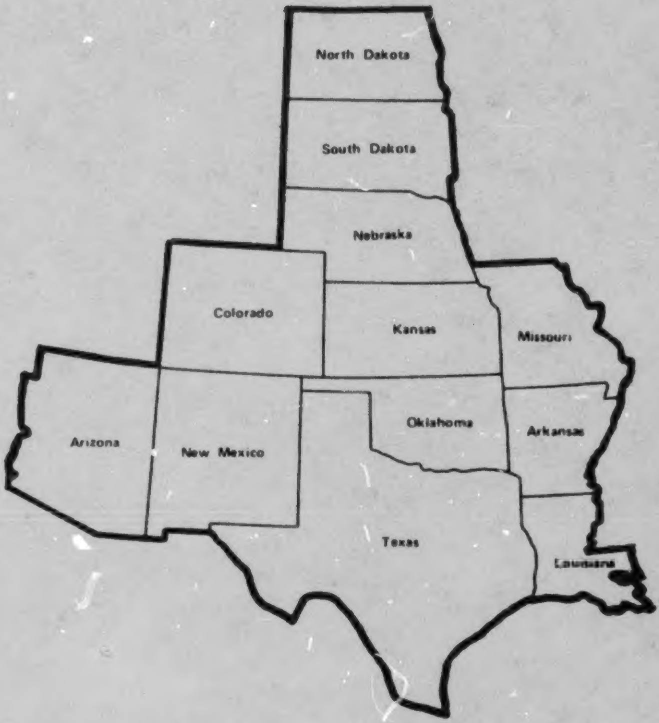
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# FOREWORD

The Mid-America Vocational Curriculum Consortium (MAVCC) was organized for the purpose of developing instructional material for the twelve member states. Priorities for developing MAVCC material are determined annually based on the needs as identified by all member states. One of the first priorities identified was small engine repair. This publication is a part of a project designed to provide the needed instructional material for small engine repair programs.

The success of this publication is due, in large part, to the capabilities of the personnel who worked with its development. Jim Hein and Mike Bundy, the technical writers, have numerous years of industry as well as teaching experience. Assisting them in their efforts were representatives of each of the member states who brought with them technical expertise and the experience related to the classroom and to the trade. To assure that the materials would parallel the industry environment and be accepted as a transportable basic teaching tool, organizations and industry representives were involved in the developmental phases of the manual. An appreciation is extended to them for their valuable contributions to the manual.

This publication is designed to assist teachers in improving instruction. As these publications are used, it is hoped that the student performance will improve and that students will be better able to assume a role in their chosen occupation, small engine and motorcycle repair.

Instructional materials in this publication are written in terms of student performance using measurable objectives. This is an innovative approach to teaching that accents and augments the teaching/learning process. Criterion referenced evaluation instruments are provided for uniform measurement of student progress. In addition to evaluating recall information, teachers are encouraged to evaluate the other areas including process and product as indicated at the end of each instructional unit.

It is the sincere belief of the MAVCC personnel and all those members who served on the committees that this publication will allow the students to become better prepared and more effective members of the work force.

Don Eshelby, Chairman
Board of Directors
Mid-America Vocational
Curriculum Consortium

# PREFACE

For many years those responsible for teaching small engine repair have felt a need for instructional materials to use in this area. A team of teachers, industry representatives and trade and industrial education staff members accepted this challenge and have produced manuals which will meet the needs of many types of courses where students are expected to become proficient in the area of small engine repair. *Motorcycle Repair* is designed to supplement the MAVCC *Comprehensive Small Engine Repair* publication by covering in detail all aspects of motorcycle mechanics not included in general engine repair or the repair of other small engines.

Instructional material in this publication is written in terms of student performance using measurable objectives. This is an innovative approach to teaching that accents and augments the teaching-learning process. Criterion referenced evaluation instruments are provided for a uniform measurement of student progress. In addition to evaluating recall information, teachers are encouraged to evaluate the other areas including process and product as indicated at the end of each instructional unit.

Every effort has been made to make this publication basic, readable and by all means usable. Three vital parts of instruction have been intentionally omitted from this publication: motivation, personalization and localization. These areas are left to the individual instructors and the instructors should capitalize on them. Only then will this publication really become a vital part of the teaching-learning process.

Ann Benson
Executive Director
Mid-America Vocational
Curriculum Consortium

# ACKNOWLEDGMENTS

Appreciation is extended to those individuals who contributed their time and talents to the development of *Motorcycle Repair*.

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Gratitude is expressed to Regina Decker and Mary Kellum for editing and to the Graphics Division of the Oklahoma State Department of Vocational and Technical Education for typing.

Special appreciation goes to Dan Stapleton for the illustrations and drawings used in this publication.

The printing staff of the Oklahoma State Department of Vocational and Technical Education are deserving of much credit for printing this publication.

## USE OF THIS PUBLICATION

### Instructional Units

The *Motorcycle Repair* curriculum includes ten areas. Each area consists of one or more units of instruction. Each instructional unit includes some or all of the basic components of a unit of instruction: performance objectives, suggested activities for teacher and students, information sheets, assignment sheets, job sheets, visual aids, tests, and answers to the test. Units are planned for more than one lesson or class period of instruction.

Careful study of each instructional unit by the teacher will help him determine:

A. The amount of material that can be covered in each class period.
B. The skills which must be demonstrated.
  1. Supplies needed
  2. Equipment needed
  3. Amount of practice needed
  4. Amount of class time needed for demonstrations
C. Supplementary materials such as pamphlets and filmstrips that must be ordered.
D. Resource people that must be contacted.

### Objectives

Each unit of instruction is based on performance objectives. These objectives state the goals of the course thus providing a sense of direction and accomplishment for the student.

Performance objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction and specific objectives, stating the student performance necessary to reach the unit objective.

Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the intent of the objectives. A limited number of performance terms have been used in the objectives for this curriculum to assist in promoting the effectiveness of the communication among all individuals using the materials.

Following is a list of performance terms and their synonyms which may have been used in this material:

Name
Label
List in writing
List orally
Letter
Record
Repeat
Give

Identify
Select
Mark
Point out
Pick out
Choose
Locate

Describe
Define
Discuss in writing
Discuss orally
Interpret
Tell how
Tell what
Explain

Order
Arrange
Sequence
List in order
Classify
Divide
Isolate
Sort

Distinguish
Discriminate

Construct
Draw
Make
Build
Design
Formulate
Reproduce
Transcribe
Reduce
Increase
Figure

Demonstrate
Show your work
Show procedure
Perform an experiment
Perform the steps
Operate
Remove
Replace
Turn off/on
(Dis) assemble
(Dis) connect

Additional Terms Used
Evaluate
Complete
Analyze
Calculate
Estimate
Plan
Observe
Compare
Determine
Perform
Prepare
Make
Read
Tell
Teach
Converse
Lead
State
Write

Reading of the objectives by the student should be followed by a class discussion to answer any questions concerning performance requirements for each instructional unit.

Teachers should feel free to add objectives which will fit the material to the needs of his students and community. When a teacher adds objectives, he should remember to supply the needed information, assignment and/or job sheets, and criterion tests.

Suggested Activities

Each unit of instruction has a suggested activities sheet outlining steps to follow in accomplishing specific objectives. The activities are listed according to whether they are the responsibility of the instructor or the student.

Instructor: Duties of the instructor will vary according to the particular unit; however, for best use of the material they should include the following: provide students with objective sheet, information sheet, assignment sheets, and job sheets; preview filmstrips, make transparencies, and arrange for resource materials and people; discuss unit and specific objectives and information sheet; give test. Teachers are encouraged to use any additional instructional activities and teaching methods to aid students in accomplishing the objectives.

Students: Student activities are listed which will help the student to achieve the objectives for the unit.

## Information Sheets

Information sheets provide content essential for meeting the cognitive (knowledge) objectives of the unit. The teacher will find that information sheets serve as an excellent guide for presenting the background knowledge necessary to develop the skills specified in the unit objective.

Students should read the information sheets before the information is discussed in class. Students may take additional notes on the information sheets.

## Transparency Masters

Transparency masters provide information in a special way. The students may see as well as hear the material being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information sheets. They are particularly effective when identification is necessary.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. They should be left on the screen only when topics shown are under discussion.

## Job Sheets

Job sheets are an important segment of each unit. The instructor should be able to and in most situations should demonstrate the skills outlined in the job sheets. Procedures outlined in the job sheets give direction to the skill being taught and allow both student and teacher to check student progress toward the accomplishment of the skill. Job sheets provide a ready outline for a student to follow if he has missed a demonstration. Job sheets also furnish potential employers with a picture of the skills being taught and the performances he might reasonably expect from a person who has had this training.

## Assignment Sheets

Assignment sheets give direction to study and furnish practice for paper and pencil activities to develop the knowledges which are necessary prerequisites to skill development. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided which may be used by the student and/or teacher for checking student progress.

## Test and Evaluation

Paper-pencil and performance tests have been constructed to measure student achievement of each objective listed in the unit of instruction. Individual test items may be pulled out and used as a short test to determine student achievement of a particular objective. This kind of testing may be used as a daily quiz and will help the teacher spot difficulties being encountered by students in their efforts to accomplish the unit objective. Test items for objectives added by the teacher should be constructed and added to the test.

## Test Answers

Test answers are provided for each unit. These may be used by the teacher and/or student for checking student achievement of the objectives.

# MOTORCYCLE REPAIR

## INSTRUCTIONAL ANALYSIS

## SECTION A--BRAKE SYSTEMS

### UNIT I--MECHANICAL DRUM AND SHOE BRAKE SYSTEMS

| JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor) | RELATED INFORMATION: What the Worker Should Know (Cognitive) |
|---|---|
| | 1. Identify parts of drum and brake system |
| | 2. Identify types of shoe brake systems |
| | 3. Distinguish between the types of brake systems |
| 4. Disassemble, inspect, and reassemble a drum and shoe brake unit | |

### UNIT II--HYDRAULIC DISC BRAKE SYSTEMS

| JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor) | RELATED INFORMATION: What the Worker Should Know (Cognitive) |
|---|---|
| | 1. List the advantages of the hydraulic disc |
| | 2. Identify the parts |
| | 3. Describe the operation of the master cylinder and brake caliper |
| 4. Remove, disassemble, inspect, reassemble, and replace a master cylinder and a brake caliper | |
| 5. Bleed a hydraulic brake system | |
| 6. Inspect a brake disc | |

## SECTION B--CLUTCHES

### UNIT I--CENTRIFUGAL CLUTCHES

| JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor) | RELATED INFORMATION: What the Worker Should Know (Cognitive) |
|---|---|
| | 1. Identify parts of the centrifugal clutch |
| | 2. List the types of centrifugal clutch weights |
| | 3. Discuss the operation of a centrifugal clutch |

| JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor) | RELATED INFORMATION: What the Worker Should Know (Cognitive) |
|---|---|
| | 5. Remove and disassemble a centrifugal clutch |
| | 6. Inspect and measure the parts of centrifugal clutch |
| | 7. Reassemble and replace a centrifugal clutch |
| | 8. Adjust a centrifugal clutch |

## UNIT II--MULTIPLATE CLUTCHES

| | |
|---|---|
| | 1. Identify parts of the multiplate clutch |
| | 2. Arrange in order the steps in the operation of a multiplate clutch |
| | 3. Select the causes of clutch failure |
| 4. Remove and disassemble a multiplate clutch | |
| 5. Inspect clutch parts | |
| 6. Reassemble and install a multiplate clutch | |
| 7. Adjust a clutch | |

## UNIT III--AUTOMOTIVE SINGLE PLATE CLUTCHES

| | |
|---|---|
| | 1. Identify the parts of the automotive single plate clutch |
| | 2. Arrange the steps of operation for a single plate clutch |
| | 3. Select causes of clutch malfunctions |
| 4. Remove, disassemble, inspect, and reinstall a single plate clutch | |

| JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor) | RELATED INFORMATION: What the Worker Should Know (Cognitive) |
|---|---|

## SECTION C--CONSTANT MESH TRANSMISSIONS

### UNIT I--CONSTANT MESH DESIGN

| JOB TRAINING | RELATED INFORMATION |
|---|---|
| | 1. Identify parts of the constant mesh transmission |
| | 2. Select types of transmission gears and shifter mechanisms |
| | 3. List the major parts of a drum shifter mechanism |
| | 4. Select major parts of a camplate and shift quadrant shifter mechanism |
| | 5. List the major parts of the ball lock shifter mechanism |

### UNIT II--CONSTANT MESH OPERATION

| JOB TRAINING | RELATED INFORMATION |
|---|---|
| | 1. Distinguish between the two gear shift patterns |
| | 2. Match shifter mechanisms to operations |
| | 3. Trace power flow through the operation |
| 4. Calculate gear ratios | |

### UNIT III--CONSTANT MESH SERVICE

| JOB TRAINING | RELATED INFORMATION |
|---|---|
| | 1. Select causes of transmission malfunctions |
| | 2. Identify crankcase designs |
| 3. Remove and disassemble a constant mesh transmission | |
| 4. Inspect, reassemble, install, and adjust a constant mesh transmission | |

## SECTION D--FINAL DRIVES

### UNIT I--CHAIN AND SPROCKET FINAL DRIVES

| JOB TRAINING | RELATED INFORMATION |
|---|---|
| | 1. Identify components of a chain and sprocket final drive |
| | 2. List the purposes of a rear hub damper |

| JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor) | RELATED INFORMATION: What the Worker Should Know (Cognitive) |
|---|---|
| | 3. Describe the construction and sizing of a roller type chain |
| | 4. Select causes of premature chain and sprocket wear |
| 5. Inspect and measure chain and sprockets | |
| 6. Adjust chain tension and alignment | |
| 7. Clean and lubricate chain | |
| 8. Check wheel tracking alignment | |

### UNIT II--SHAFT FINAL DRIVES

| | |
|---|---|
| | 1. Identify major components |
| | 2. Match components to functions |
| | 3. Distinguish between correct, forward, and rearward gear teeth patterns. |
| 4. Remove, disassemble, and inspect final drive unit | |
| 5. Reassemble and adjust final drive unit | |
| 6. Remove and inspect drive shaft | |
| 7 Install drive shaft and final drive unit | |

## SECTION E--SUSPENSION
### UNIT I--WHEEL LACING AND TRUING

| | |
|---|---|
| | 1. Identify the inner spoke and outer spoke |
| | 2. Identify cross spoke patterns |
| 3. Remove and replace a rim | |
| 4. Lace a wheel | |
| 5. True a wheel | |
| 6. Replace spokes | |

| JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor) | RELATED INFORMATION: What the Worker Should Know (Cognitive) |
|---|---|
| **UNIT II--WHEEL BEARINGS, AXLES, AND BALANCING** | |
| | 1. Identify types of wheel bearings |
| | 2. Match types to construction characteristics |
| 3. Service wheel bearings and related parts | |
| 4. Static balance a wheel | |
| **UNIT III--FRONT FORKS AND STEERING STEM** | |
| | 1. Identify the parts of the telescoping hydraulic forks |
| | 2. Identify the parts of the steering stem assembly |
| | 3. Distinguish between a single dampening system and a double dampening system |
| | 4. Describe the operation of the telescoping hydraulic forks on compression and rebound |
| | 5. List the purposes of the steering damper |
| 6. Change the hydraulic fluid in the forks | |
| 7. Disassemble, inspect, and reassemble the telescoping hydraulic fork | |
| **UNIT IV--REAR SWING ARM AND SHOCKS** | |
| | 1. List the four major components of the rear suspension system |
| | 2. Identify the parts of the rear swing arm assembly |
| | 3. Identify the parts of the shock absorber assembly |
| | 4. Describe the operation of the rear swing arm suspension system on compression and rebound |

JOB TRAINING: What the Worker Should Be Able to Do
(Psychomotor)

RELATED INFORMATION: What the Worker Should Know
(Cognitive)

5. Check and adjust rear shock absorbers

6. Remove, check, service, and install rear swing arm assembly

## SECTION F--MECHANICAL STARTING MECHANISMS
## UNIT I--KICKSTARTERS

1. Identify the parts of the pawl ratchet kickstarter

2. Describe the operation of the pawl ratchet kickstarter

3. Identify the parts of the full ratchet kickstarter

4. Describe the operation of the full ratchet kickstarter

5. Identify the parts of the lateral engagement kickstarter

6. Describe the operation of the lateral engagement kickstarter

7. Identify the parts of the quadrant gear kickstarter

8. Describe the operation of the quadrant gear kickstarter

9. Demonstrate the ability to remove, inspect, service, and replace a pawl ratchet kickstarter

## SECTION G--ELECTRICAL SYSTEMS
## UNIT I--AC PERMANENT MAGNET SINGLE PHASE CHARGING SYSTEM

1. Select the components of the AC permanent magnet single phase charging system

2. Identify the types of single phase coil connections

3. Distinguish between the two types of charging systems

4. Describe the operation of the half-wave charging system

| JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor) | RELATED INFORMATION: What the Worker Should Know (Cognitive) |
|---|---|
|  | 5. Describe the operation of the full-wave charging system |
| 6. Test DC charging rate |  |
| 7. Test alternator charging and lighting coils output |  |
| 8. Test stator assembly, rectifiers, and regulators |  |

## UNIT II--AC ELECTROMAGNETIC THREE PHASE CHARGING SYSTEM

|  |  |
|---|---|
|  | 1. Select the major components of the electromagnetic three phase charging sytem |
|  | 2. Identify the types of three phase coil connections. |
|  | 3. Select the circuits used in the AC electromagnetic three phase charging system. |
|  | 4. Describe the operation of the alternator |
|  | 5. Describe the operation of the mechanical voltage regulator |
| 6. Test the DC charging rate |  |
| 7. Bench test field coils, stator assembly, and rectifiers |  |
| 8. Check and adjust voltage regulator |  |

## UNIT III--BATTERY IGNITION SYSTEMS

|  |  |
|---|---|
|  | 1. Identify the components of a battery ignition system |
|  | 2. Select the types of battery ignition system designs |
|  | 3. Match the types of multicylinder ignition system designs to the correct operating characteristics |
| 4. Adjust ignition timing with dial indicator and ohmmeter |  |

JOB TRAINING: What the Worker Should Be Able to Do
(Psychomotor)

RELATED INFORMATION: What the Worker Should Know
(Cognitive)

5. Adjust ignition timing with reference marks

6. Check ignition timing and advance with timing light and tachometer

## UNIT IV--ENERGY TRANSFER IGNITION SYSTEMS

1. Identify the components of the energy transfer ignition system

2. Describe the operation of the energy transfer ignition system

3. Distinguish between the energy transfer ignition system and the conventional magneto ignition system.

4. Test an energy transfer system for continuity and grounds

## UNIT V--CAPACITOR DISCHARGE IGNITION SYSTEMS

1. Discuss the advantages of the CDI system

2. Identify the major components of the CDI system

3. Arrange in order the steps in the operation of the CDI system

4. Test exciter and signal coils

5. Test ignition coil

## UNIT VI--ELECTRICAL STARTING SYSTEMS

1. List seven components of an electrical starting system

2. Describe the operation of the solenoid

3. Arrange in order the steps in the operation of the starting system

4. Describe the operation of the overrunning clutch

| JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor) | RELATED INFORMATION: What the Worker Should Know (Cognitive) |
|---|---|
| 5. Trace starter circuits on a wiring diagram | |
| 6. Test starter circuits | |

### SECTION H--FUEL SYSTEMS
### UNIT I--SLIDE VALVE CARBURETORS

| JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor) | RELATED INFORMATION: What the Worker Should Know (Cognitive) |
|---|---|
| | 1. Distinguish between direct control and constant velocity slide valve carburetors |
| | 2. Select the systems of a slide valve carburetor |
| | 3. Describe the operation of the float system |
| | 4. Describe the operation of the starter system |
| | 5. Describe the operation of the pilot and intermediate speed system |
| | 6. Describe the operation of the main system |
| | 7. Discuss the differences in operation between the two types of slide valve carburetors |
| 8. Disassemble, service, and reassemble a slide valve carburetor | |
| 9. Adjust idle speed and mixture on a slide valve carburetor | |

### SECTION I--LUBRICATION SYSTEMS
### UNIT I--2-STROKE OIL INJECTION SYSTEMS

| JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor) | RELATED INFORMATION: What the Worker Should Know (Cognitive) |
|---|---|
| | 1. Identify the components of the 2-stroke oil injection system |
| | 2. Discuss the designs of oil injection systems |
| | 3. Discuss oil injection pumps |
| | 4. List the purposes of check valves |

| JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor) | RELATED INFORMATION: What the Worker Should Know (Cognitive) |
|---|---|
| 5. Check and adjust the injection pump control cable | |
| 6. Bleed an oil injection system | |

## SECTION J--OVERHEAD CAMSHAFTS
## UNIT I--OVERHEAD CAMSHAFTS

| JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor) | RELATED INFORMATION: What the Worker Should Know (Cognitive) |
|---|---|
| | 1. Identify the major components of the overhead camshaft system |
| | 2. Select the types of overhead camshaft drives |
| | 3. Identify the types of tensioners |
| | 4. Discuss the operation of the overhead camshaft system |
| 5. Remove, inspect, and reinstall an overhead camshaft | |
| 6. Adjust a tensioning device | |

## TOOLS

(NOTE: These are the recommended tools and equipment necessary to complete the jobs required in these instructional materials.

Hand Tool Assortment:
- One pound hammer - ball peen
- Slip joint pliers
- Screwdrivers
  - 4" standard
  - 1 1/2" standard
  - 8" standard
  - 6" standard
- Adjustable wrench
- Phillips screwdrivers
  - 6"
  - 1 1/2"
  - 8"
- 3/8" drive reversible rachet
- 3/8" drive standard socket set
- 1/4" drive reversible rachet
- 1/4" drive standard socket set
- 3/8" drive extension bar - 3 in.
- 3/8" drive extension bar - 7 1/2 in.
- Starter punch
- Cold chisel
- Combination wrench set 7/16 to 7/8 in.
- Universal joint
- Open end wrench set - metric
- 3/8 drive socket set - metric

Other Tools and Equipment:
- Safety glasses
- Motorcycle stand or block
- Combination wrench set - metric
- Vernier caliper
- Drain pan
- Brake cylinder hone
- Hex key
- Inside micrometer
- Outside micrometer
- Bleeder tube
- Dial indicator
- End wrenches
- Impact screwdriver set
- Snap ring pliers
- T-handle box wrench, 16 mm
- Arbor press or bench vise
- Feeler gauge
- Flat surface plate
- Machinist's steel rule
- Calipers
- Surface block
- Case divider tool
- Impact driver
- 3/8" drive phillips screwdriver socket
- Soft face hammer
- Tape measure
- Cleaning pan
- Cleaning brush
- Grease pan
- Hot plate
- Thermomelt stick
- Plastic hammer
- Parts washing pan
- Pin wrench
- Propane torch
- Seal driver set
- Meter/kilogram torque wrench
- Soft drift
- Nipple wrench
- Wheel truing stand
- Tire pressure gauge
- Bushing driver set
- Brass drift
- Pry bar
- Pliers
- Measuring container
- Cylinder gauge
- Shock absorber compressor
- Hydraulic press
- Drift punch
- V-blocks
- Surface plate
- DC voltmeter
- DC ammeter
- Test lamp
- Full-wave and half-wave rectifier
- SCR regulator
- Ohmmeter
- Spark plug wrench
- Ignition point gauge
- Tachometer
- Flywheel pullers
- Float level gauge
- 0-1" telescoping gauge

# REFERENCES

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*Suzuki 350 Parts Catalogue.* Suzuki Motor Co., Ltd., 1972.

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*Suzuki 125 and T-125 Service Manual.* Suzuki Motor Co., Ltd., 1969.

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*Suzuki 500 Service Manual.* Suzuki Motor Co., Ltd., 1969.

*Suzuki T- 500 - 2 Service Manual.* Suzuki Motor Co., Ltd., 1969.

*Suzuki GT550 Service Manual.* Suzuki Motor Co., Ltd., 1973.

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# MECHANICAL DRUM AND SHOE BRAKE SYSTEMS
## UNIT I

## UNIT OBJECTIVE

After completion of this unit, the student should be able to match the terms associated with mechanical drum and shoe brake systems to the correct definitions and identify the parts. The student should also be able to distinguish between the types of brake systems and demonstrate the ability to disassemble, inspect, and reassemble a drum and shoe brake unit. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with mechanical drum and shoe brake systems to the correct definitions.
2. Identify the parts of a mechanical drum and shoe brake system.
3. Identify the types of drum and shoe brake systems.
4. Name the most frequent utilization of the single and double leading shoe systems.
5. Distinguish between the types of brake systems.
6. Demonstrate the ability to disassemble, inspect, and reassemble a drum and shoe brake unit.

# MECHANICAL DRUM AND SHOE BRAKE SYSTEMS
## UNIT I

## SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide student with objective sheet.
- B. Provide student with information, assignment, and job sheets.
- C. Make transparencies.
- D. Discuss unit and specific objectives.
- E. Discuss information and assignment sheets.
- F. Demonstrate and discuss the procedure outlined in the job sheet.
- G. Give test.

II. Student:

- A. Read objective sheet.
- B. Study information sheet.
- C. Complete assignment and job sheets.
- D. Complete activities assigned by instructor.
- E. Take test.

## INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheet
- C. Transparency masters
  - 1. TM 1--Mechanical Drum and Shoe Brake System Parts
  - 2. TM 2--Single Leading Shoe Brake System
  - 3. TM 3--Double Leading Shoe Brake System

D. Assignment sheets

1. Assignment Sheet #1--Identify Brake Parts

2. Assignment Sheet #2--Match Terms and Definitions

E. Job Sheet #1--Disassemble, Inspect, and Reassemble a Drum and Shoe Brake Unit

F. Test

G. Answers to test

II. References:

A. *Chilton's New Motorcycle Troubleshooting Guide.* Radnor, Pennsylvania: Chilton Book Co., 1973.

B. *Honda Service Manuals.* Honda Motor Co., Ltd.

C. *Motorcycle Systems Training Manuals.* Kawasaki Motors Corp.

D. *Suzuki Service Manuals.* Suzuki Motor Co., Ltd.

# MECHANICAL DRUM AND SHOE BRAKE SYSTEMS
## UNIT I

## INFORMATION SHEET

I. Terms and definitions

  A. Drum--Housing that rotates around the brake assembly providing a smooth surface for the brake shoes to contact and produce the braking action

  B. Brake actuating cam--Eccentric pin that causes a spreading action of the brake shoes when rotated

  C. Brake shoes--Arched metal pieces that have the friction material bonded to them

  D. Backing plate--Rigid plate anchored to the vehicle frame upon which the brake shoes and other parts are mounted

  E. Brake shoe pivot--Steel shaft or pin which acts as rotation point for brake shoes when activated

  F. Self-actuation--Tendency of the turning drum to grip and pull the leading shoe into contact

  G. Leading shoe--Brake shoe which is mounted so that its pivot point is at the bottom of rotation as the wheel rolls forward

  H. Single leading shoe system--Brake unit containing one actuating cam, one pivot, one leading shoe, and one trailing shoe

  (NOTE: This system is most often found on the rear wheel brake.)

  I. Double leading shoe system--Brake unit containing two actuating cams, two pivots, and two leading shoes

II. Parts of mechanical drum and shoe brake system (Transparency 1)

  A. Drum

  B. Shoes

  C. Brake cam

  D. Cam lever

  E. Return springs

  F. Control cable

## INFORMATION SHEET

G. Cam lever connecting rod

H. Cooling air vents

I. Backing plate

J. Pivot pin

K. Hand lever

L. Foot pedal

M. Rear brake rod

III. Types of drum and shoe brake systems (Transparencies 2 and 3)

A. Single leading shoe brake system

B. Double leading shoe brake system

IV. Utilization of single and double leading shoe systems

A. Single leading shoe type--Rear wheel

(NOTE: It is also found on the front wheels of many lightweight, racing or off the road motorcycles.)

B. Double leading shoe type--Front wheel

V. Operation of types of brake systems

A. Single leading shoe (Transparency 2)

1. Pressure is applied to brake hand lever or foot pedal

a. Single cam is rotated

b. Shoes spread by rotating cam

c. Shoes forced against drum creating friction

2. Leading shoe receives added boost from "self-actuation" principle

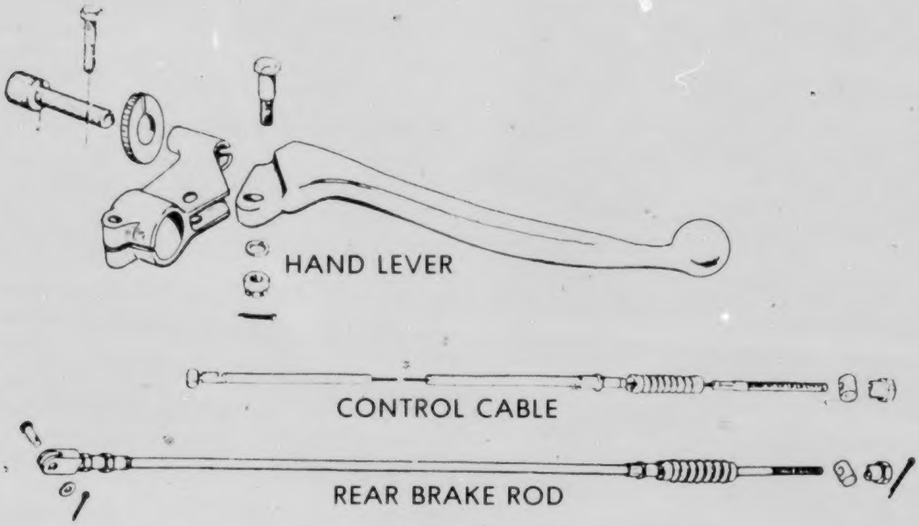
3. Trailing shoe braking force generated by force of cam alone

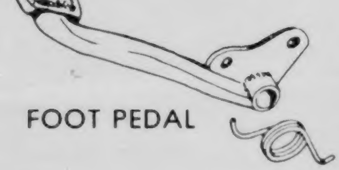
4. Friction between brake shoes and brake drum provides stopping force

## INFORMATION SHEET

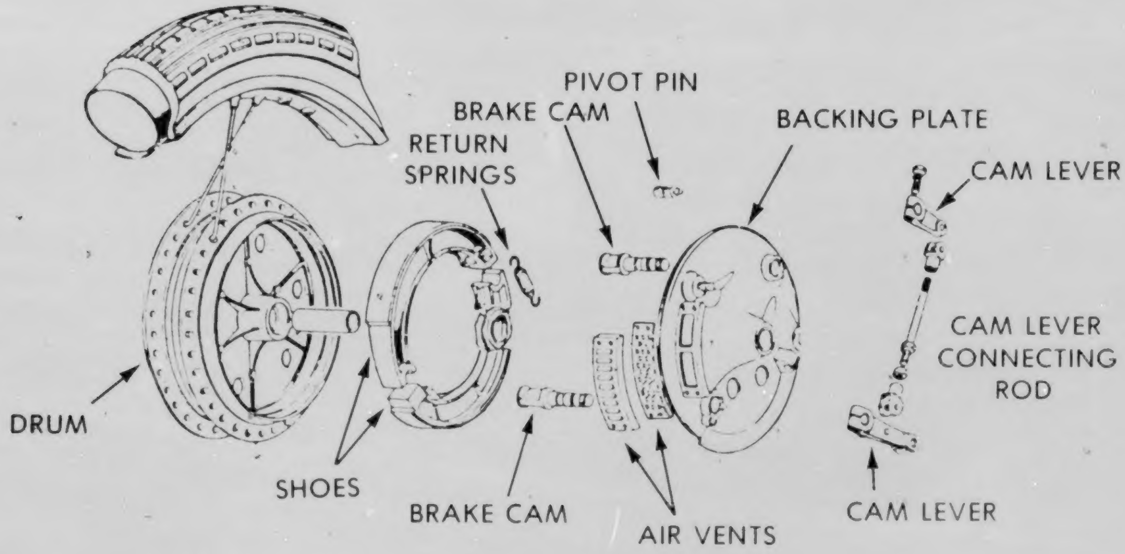
B. Double leading shoe (Transparency 3)

1. Pressure is applied to brake hand lever or foot pedal
    a. Cams, connected by connecting rod, are rotated together
    b. One shoe spread by each cam
    c. Shoes forced against drum creating friction
2. Both sides receive added boost from "self-actuation" principle
3. Both are leading shoes, and net braking force is greatly increased
4. Friction between brake shoes and brake drum provides stopping force

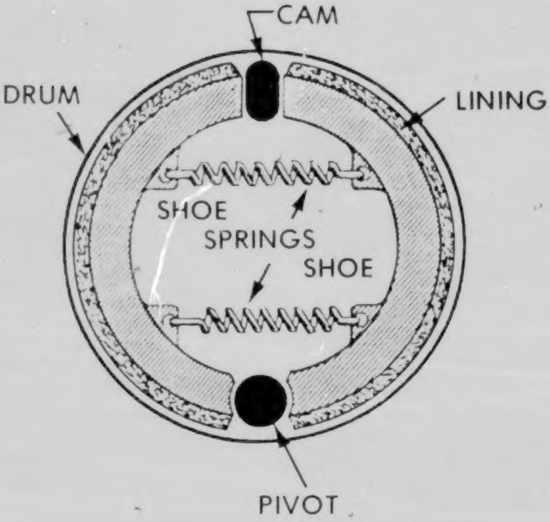

HAND LEVER
CONTROL CABLE
REAR BRAKE ROD

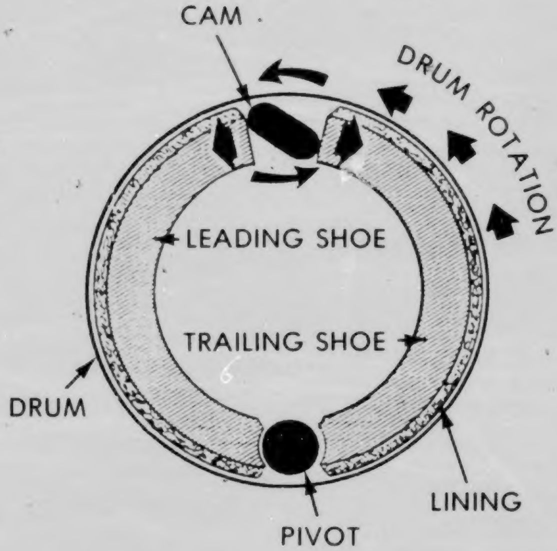


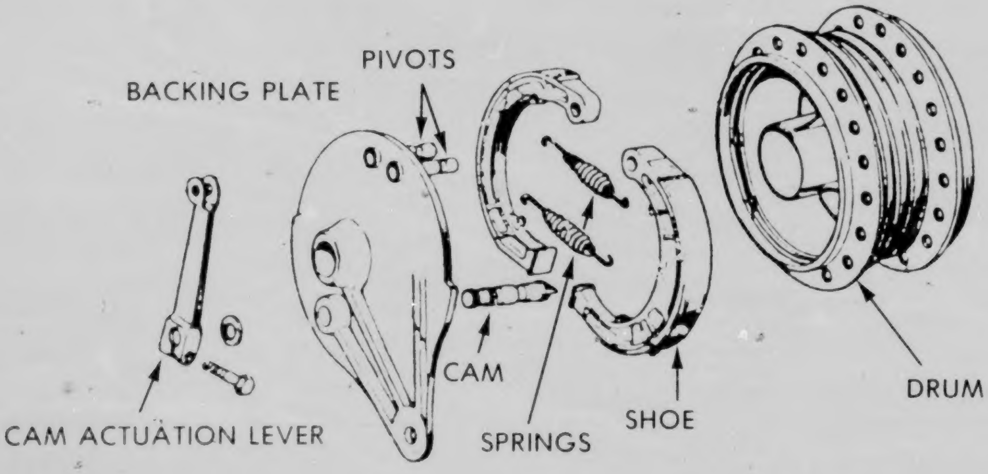
# Mechanical Drum and Shoe Brake System Parts

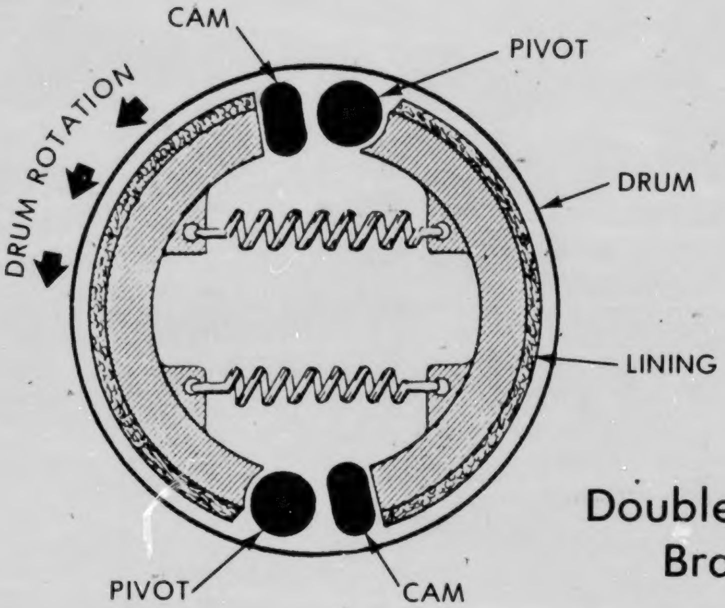

PIVOT PIN
BRAKE CAM
BACKING PLATE
RETURN SPRINGS
CAM LEVER
CAM LEVER CONNECTING ROD
DRUM
SHOES
BRAKE CAM
AIR VENTS
CAM LEVER

# Single Leading Shoe Brake System

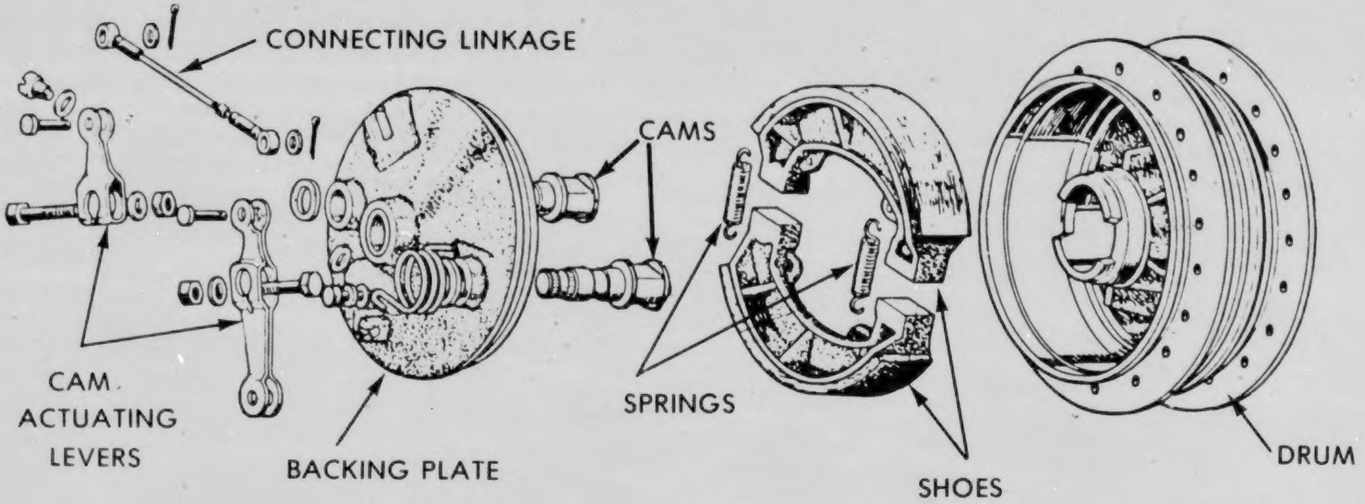

CAM
DRUM
LINING
SHOE
SPRINGS
SHOE
PIVOT


CAM
DRUM ROTATION
LEADING SHOE
TRAILING SHOE
DRUM
LINING
PIVOT


PIVOTS
BACKING PLATE
CAM
CAM ACTUATION LEVER
SPRINGS
SHOE
DRUM


CAM
PIVOT
DRUM ROTATION
DRUM
LINING
PIVOT
CAM

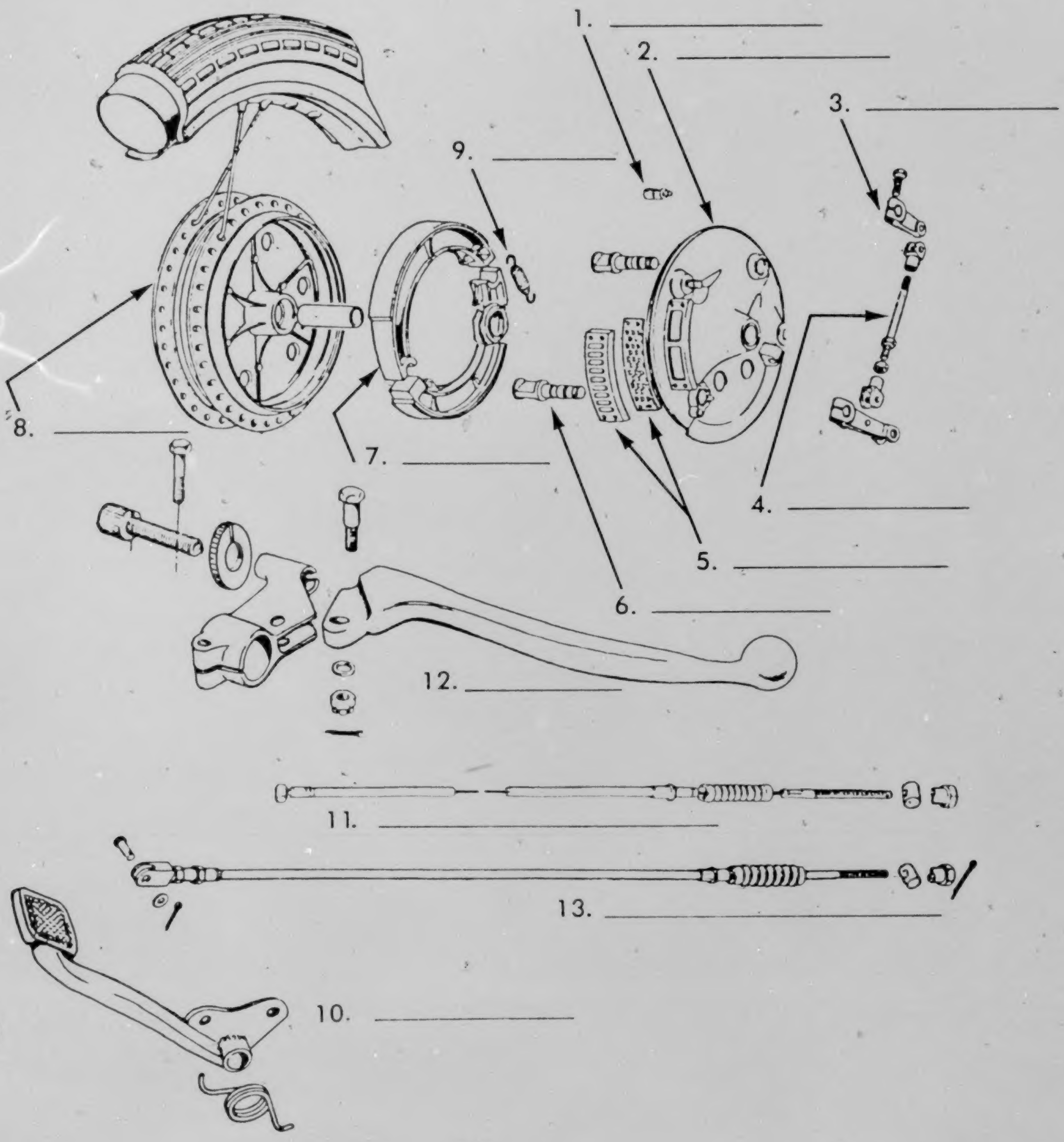
Double Leading Shoe Brake System


CONNECTING LINKAGE
CAMS
CAM ACTUATING LEVERS
BACKING PLATE
SPRINGS
SHOES
DRUM

## MECHANICAL DRUM AND SHOE BRAKE SYSTEMS
## UNIT I

### ASSIGNMENT SHEET #1--IDENTIFY BRAKE PARTS

From the illustration identify each part of the mechanical drum and shoe brake system.



1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________
11. ____________________
12. ____________________
13. ____________________

# MECHANICAL DRUM AND SHOE BRAKE SYSTEMS
## UNIT I

## ASSIGNMENT SHEET #2--MATCH TERMS AND DEFINITIONS

Match the terms on the right to the correct definitions.

_____a. Rigid plate anchored to the vehicle frame upon which the brake shoes and other parts are mounted

_____b. Brake shoe which is mounted so that its pivot point is at the bottom of rotation as the wheel rolls forward

_____c. Tendency of the turning drum to grip and pull the leading shoe into contact

_____d. Brake unit containing two actuating cams, two pivots, and two leading shoes

_____e. Eccentric pin that causes a spreading action of the brake shoes when rotated

_____f. Brake unit containing one actuating cam, one pivot, one leading shoe, and one trailing shoe

_____g. Steel shaft or pin which acts as rotation point for brake shoes when activated

_____h. Arched metal pieces that have the friction material bonded to them

_____i. Housing that rotates around the brake assembly providing a smooth surface for the brake shoes to contact and produce the braking action

1. Brake shoes
2. Brake actuating cam
3. Drum
4. Backing plate
5. Leading shoe
6. Brake shoe pivot
7. Single leading shoe system
8. Double leading shoe system
9. Self-actuation

# MECHANICAL DRUM AND SHOE BRAKE SYSTEMS
## UNIT I

## ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. Pivot pin
2. Backing plate
3. Cam lever
4. Cam lever connecting rod
5. Cooling air vents
6. Brake cam
7. Shoes
8. Drum
9. Return springs
10. Foot pedal
11. Control cable
12. Hand lever
13. Rear brake rod

Assignment Sheet #2

| | | | |
|---|---|---|---|
| a. | 4 | f. | 7 |
| b. | 5 | g. | 6 |
| c. | 9 | h. | 1 |
| d. | 8 | i. | 3 |
| e. | 2 | | |

# MECHANICAL DRUM AND SHOE BRAKE SYSTEMS
# UNIT I

## JOB SHEET #1--DISASSEMBLE, INSPECT, AND REASSEMBLE A DRUM AND SHOE BRAKE UNIT

I. Tools and materials

   A. Safety glasses

   B. Motorcycle stand or blocks

   C. Metric wrench set

   D. Hand tool assortment

   E. Vernier caliper or other suitable measuring instrument

   F. Appropriate service manual

II. Procedure

   A. Raise and support front of cycle on motorcycle stand or blocks

   B. Disconnect brake cable

   C. Disconnect speedometer cable, if used

   D. Remove brake backing plate anchor arm, if used

   E. Remove the U shaped axle holders

   F. Remove wheel axle and spacers

   G. Remove wheel and brake assembly

   H. Separate backing plate and attached components from brake drum

   I. Remove cam levers and connecting rod

   J. Remove the return springs and shoes by folding the shoes inward

   K. Remove brake cams

   L. Check cams for thickness and for bent or warped conditions

   M. Check return springs for length and tension

   N. Inspect brake drum for scoring or distortion

## JOB SHEET #1

O. Measure brake drum for wear and out-of-round

P. Inspect brake lining for scoring or glazing

Q. Measure lining thickness

R. Compare all measurements with standard specifications using appropriate service manual

S. Reassemble brake unit

T. Reinstall wheel and brake unit on motorcycle

(NOTE: Be certain backing plate anchor is engaged or securely bolted to cycle.)

U. Adjust brake cable to obtain proper hand lever free play as described in appropriate service manual

## MECHANICAL DRUM AND SHOE BRAKE SYSTEMS
## UNIT I

## TEST

1. Match the terms on the right to the correct definitions.

_____a. Eccentric pin that causes a spreading action of the brake shoes when rotated

_____b. Rigid plate anchored to the vehicle frame upon which the brake shoes and other parts are mounted

_____c. Brake shoe which is mounted so that its pivot point is at the bottom of rotation as the wheel rolls forward

_____d. Brake unit containing two actuating cams, two pivots, and two leading shoes

_____e. Housing that rotates around the brake assembly providing a smooth surface for the brake shoes to contact and produce the braking action

_____f. Arched metal pieces that have the friction material bonded to them

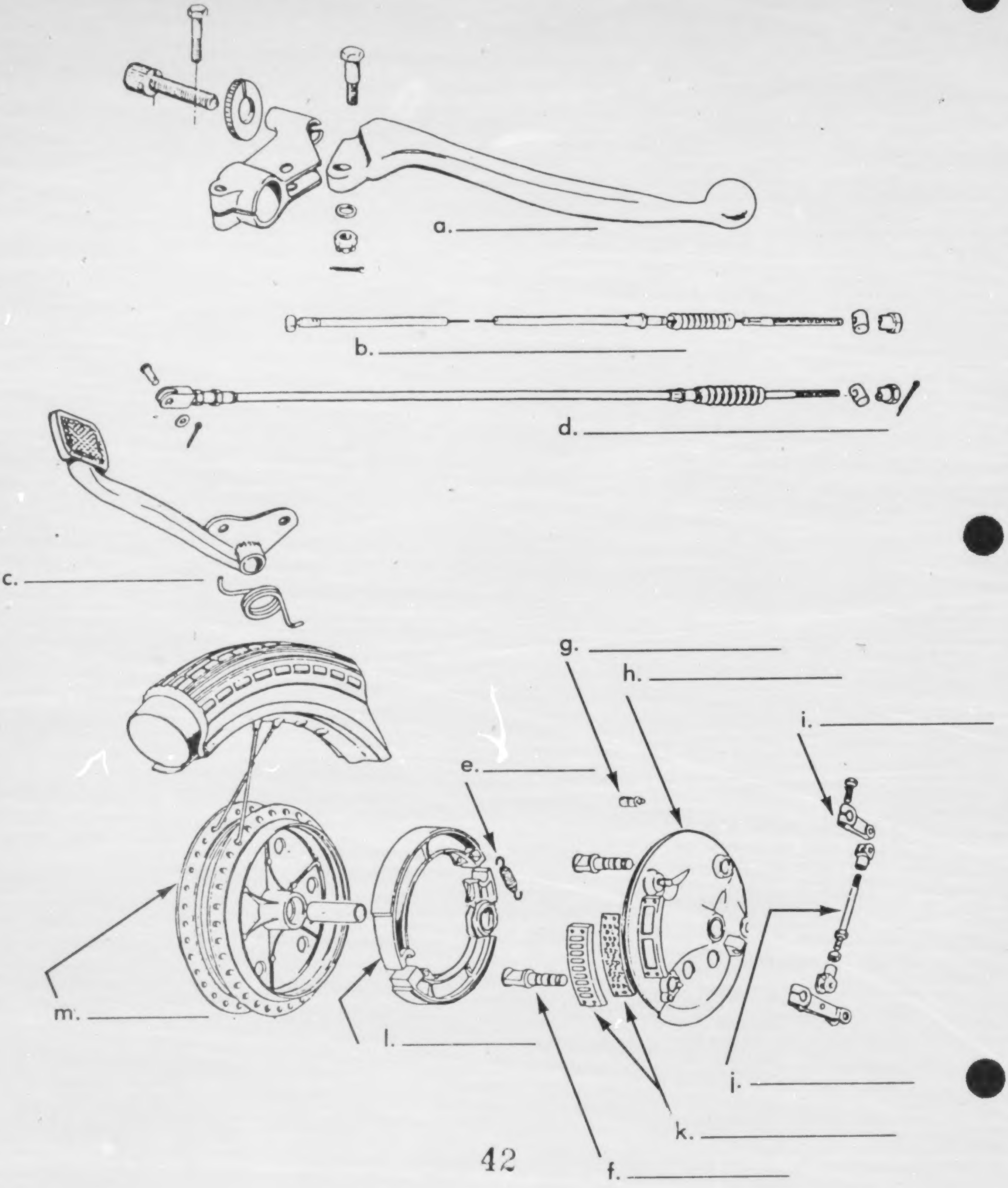
_____g. Steel shaft or pin which acts as rotation point for brake shoes when activated

_____h. Brake unit containing one actuating cam, one pivot, one leading shoe, and one trailing shoe

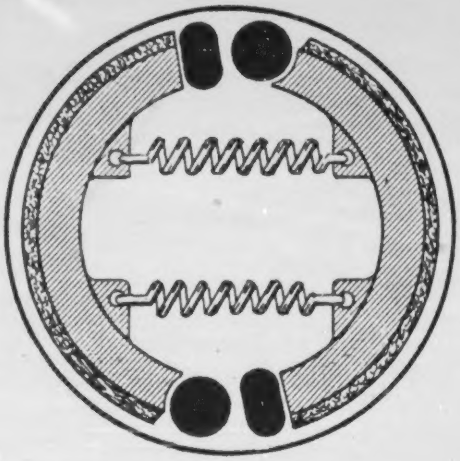
_____i. Tendency of the turning drum to grip and pull the leading shoe into contact

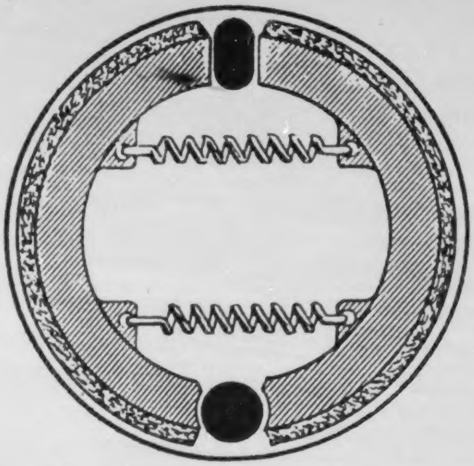
1. Brake shoe pivot
2. Drum
3. Brake shoes
4. Double leading shoe system
5. Brake actuating cam
6. Self-actuation
7. Backing plate
8. Leading shoe
9. Single leading shoe system

2. Identify the parts of a mechanical drum and shoe brake system.


a. ______________
b. ______________
d. ______________
c. ______________
g. ______________
h. ______________
i. ______________
e. ______________
m. ______________
l. ______________
j. ______________
k. ______________
f. ______________

3. Identify the types of drum and shoe brake systems.





a. ____________ ____________ b. ____________ ____________

4. Name the most frequent utilization of the single and double leading shoe systems.

   a. Single leading shoe type--

   b. Double leading shoe type--

5. Distinguish between the types of brake systems by placing an "X" next to the operational descriptions of the double leading shoe system.

______a.

   1) Pressure is applied to brake hand lever or foot pedal

      a) Single cam is rotated

      b) Shoes spread by rotating cam

      c) Shoes forced against drum creating friction

   2) Leading shoe receives added boost from "self-actuation" principle

   3) Trailing shoe braking force generated by force of cam alone

   4) Friction between brake shoes and brake drum provides stopping force

______b.

   1) Pressure is applied to brake hand lever or foot pedal

      a) Cams, connected by connecting rod, are rotated together

b) One shoe spread by each cam

c) Shoes forced against drum creating friction

2) Both sides receive added boost from "self-actuation" principle

3) Both are leading shoes, and net braking force is greatly increased

4) Friction between brake shoes and brake drum provides stopping force

6. Demonstrate the ability to disassemble, inspect, and reassemble a drum and shoe brake unit.

(NOTE: If this activity has not been accomplished prior to the test, ask your instructor when it should be completed.)

## MECHANICAL DRUM AND SHOE BRAKE SYSTEMS
## UNIT I

### ANSWERS TO TEST

1. a. 5 f. 3
   b. 7 g. 1
   c. 8 h. 9
   d. 4 i. 6
   e. 2

2. a. Hand lever
   b. Control cable
   c. Foot pedal
   d. Rear brake rod
   e. Return springs
   f. Brake cam
   g. Pivot pin
   h. Backing plate
   i. Cam lever
   j. Cam lever connecting rod
   k. Cooling air vents
   l. Shoes
   m. Drum

3. a. Double leading shoe brake system
   b. Single leading shoe brake system

4. a. Rear wheel
   b. Front wheel

5. b.

6. Performance skill evaluated to the satisfaction of the instructor

# HYDRAULIC DISC BRAKE SYSTEMS
## UNIT II

## UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms associated with hydraulic disc brake systems to the correct definitions, list the advantages of this system, name the main parts of the hydraulic disc brake system, and describe the operations of the master cylinder and the brake calipers. The student should also be able to remove, inspect, and replace a master cylinder and a brake caliper, demonstrate the proper procedure for bleeding the hydraulic disc brake system, and inspect and check the brake disc. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with hydraulic disc brake systems to the correct definitions.
2. List the advantages of the hydraulic disc brake system.
3. Name the main parts of the hydraulic disc brake system.
4. Identify the parts of the master cylinder.
5. Identify the parts of the brake caliper.
6. Discuss the care and handling of hydraulic brake fluid.
7. Describe the operation of the master cylinder.
8. Describe the operation of the brake caliper.
9. Demonstrate the ability to:
    - a. Remove, disassemble, inspect, reassemble, and replace a master cylinder.
    - b. Remove, disassemble, inspect, and reassemble a brake caliper.
    - c. Bleed the hydraulic disc brake system.
    - d. Inspect and check the brake disc.

## HYDRAULIC DISC BRAKE SYSTEMS
## UNIT II

### SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information, assignment, and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information and assignment sheets.

  F. Demonstrate and discuss the procedures outlined in the job sheets.

  G. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Complete assignment and job sheets.

  D. Complete activities assigned by instructor.

  E. Take test.

### INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Parts of Hydraulic Disc Brake System

    2. TM 2--Parts of Master Cylinder

3. TM 3--Parts of a Brake Caliper

4. TM 4--Operation of Master Cylinder-Brake Application

5. TM 5--Operation of Master Cylinder-Brake Release

6. TM 6--Brake Caliper Application-First Stage

7. TM 7--Brake Caliper Application-Second Stage and at Rest Position

D. Assignment sheets

1. Assignment Sheet #1--Identify the Master Cylinder Parts

2. Assignment Sheet #2--Identify the Brake Caliper Parts

E. Answers to assignment sheets

F. Job sheets

1. Job Sheet #1--Remove, Disassemble, Inspect, Reassemble, and Replace a Master Cylinder

2. Job Sheet #2--Remove, Disassemble, Inspect, and Reassemble a Brake Caliper

3. Job Sheet #3--Bleed the Hydraulic Disc Brake System

4. Job Sheet #4--Inspect and Check the Brake Disc

G. Test

H. Answers to test

II. References:

A. *Honda 750 Service Manual.* Honda Motor Co., Ltd.

B. *Motorcycle Systems Training Manual.* Kawasaki Motors Corp., 1973.

C. *Suzuki Service Manual.* Suzuki Motor Co., Ltd., 1973.

D. *Kawasaki 500 Service Manual.* Kawasaki Motors Corp.

E. *Chilton's New Motorcycle Troubleshooting Guide.* Radnor, Pennsylvania: Chilton Book Co., 1973.

F. *Chilton's Repair and Tune-Up Guide for the Harley-Davidson.* Radnor, Pennsylvania: Chilton Book Co., 1973.

# HYDRAULIC DISC BRAKE SYSTEMS
## UNIT II

## INFORMATION SHEET

I. Terms and definitions

- A. Disc brakes--Braking system utilizing a caliper which compresses brake pads against a circular disc
- B. Hydraulic pressure--Force exerted by a fluid as a result of an attempt to compress the fluid
- C. Force multiplication--Basic principle of hydraulics whereby the force applied to pressurize a fluid is increased in direct proportion to the difference in surface area of the two pistons

  (NOTE: This is calculated by using the formula, $F = P \times A$.)
- D. Friction--Resistance to relative movement between two bodies in contact
- E. Brake fluid--Special fluid containing either a glycol or silicone base that is used in hydraulic brake systems
- F. Noncompressible--Basic property of fluids which means they cannot be reduced in volume by pressure
- G. Boiling point--Temperature at which fluids begin to vaporize
- H. Brake lining glaze--Hard slick finish that forms on brake lining due to heat and friction
- I. Brake fade--Condition caused by heat or moisture that decreases friction and the resulting braking power of the system
- J. Brake bleeding--Process of expelling air from the hydraulic system

II. Advantages of hydraulic disc brake system

- A. Minimum brake fade due to greater heat dissipation
- B. Greater braking power
- C. Greater reliability
- D. Self-adjusting
- E. Easier to inspect for lining wear

## INFORMATION SHEET

III. Main parts of hydraulic disc brake system (Transparency 1)
  A. Master cylinder
  B. Brake hoses or lines
  C. Caliper and pad assembly
  D. Brake disc

IV. Parts of master cylinder (Transparency 2)
  A. Master cylinder body
  B. Cylinder cap
  C. Plate
  D. Diaphragm
  E. Dust seal retainer
  F. Dust seal
  G. Snap ring
  H. Piston stop plate
  I. Secondary cup
  J. Piston
  K. Primary cup
  L. Return spring
  M. Check valve
  N. Brake lever
  O. Lever adjusting bolt
  P. Mounting bracket
  Q. Hose and fittings

V. Parts of brake caliper (Transparency 3)
  A. Caliper body halves
  B. Caliper holder

## INFORMATION SHEET

- C. Caliper seal ring
- D. Pads
- E. Dust seal retainer
- F. Dust seal
- G. Hydraulic piston
- H. Piston seal
- I. Bleeder valve
- J. Bleeder valve cap
- K. Caliper axle or shaft
- L. Caliper mounting bolts
- M. Dust seals, caliper axle
- N. Brake disc

VI. Care and handling of hydraulic brake fluid

- A. Keep hydraulic brake fluid clean and free of moisture

  (NOTE: Dirt or other abrasive materials can score the piston and cylinder surfaces, and water in the fluid will lower the boiling point of the fluid to a dangerous level.)

- B. Do not mix hydraulic brake fluids having different bases

  (NOTE: Most hydraulic disc brake systems use a glycol base fluid.)

- C. Do not reuse old brake fluid

  (NOTE: Such fluid may be contaminated and harmful to the system.)

- D. Do not spill brake fluid on painted surfaces or gauges

  (NOTE: The fluid will remove paint and will damage gauge lenses.)

VII. Operation of master cylinder (Transparencies 4 and 5)

- A. Operator compresses brake lever
  - 1. Piston and primary and secondary cups move inward

## INFORMATION SHEET

   2. Fluid is trapped and pressurized as cups seal off return port
   3. Fluid under pressure is forced through check valve and brake lines to the caliper
   4. Return spring in master cylinder is being compressed throughout this operation

 B. Operator releases brake lever

   1. Piston and cups are pushed back by compressed return spring
   2. Piston moves back faster than fluid returns from caliper creating a void in front of piston
   3. Void in front of secondary cup is filled by
      a. Fluid flowing in from reservoir
      b. Fluid from behind piston flowing through small holes in piston past primary cup
   4. Fluid returning from caliper
      a. Passes check valve
      b. Passes through return port to reservoir

VIII. Operation of brake caliper (Transparencies 6 and 7)

 A. Operator compresses brake lever

   1. Fluid under pressure pushes piston and applies force to pad
   2. Piston movement causes seal to deform slightly
   3. Brake pad contacts brake disc
      a. Caliper body reacts by sliding on caliper axle
      b. Caliper's sliding action pulls second pad into contact with brake disc
      c. Brake disc is clamped between pads to create braking friction

## INFORMATION SHEET

B. Operator releases brake lever

    1. Fluid pressure is eliminated

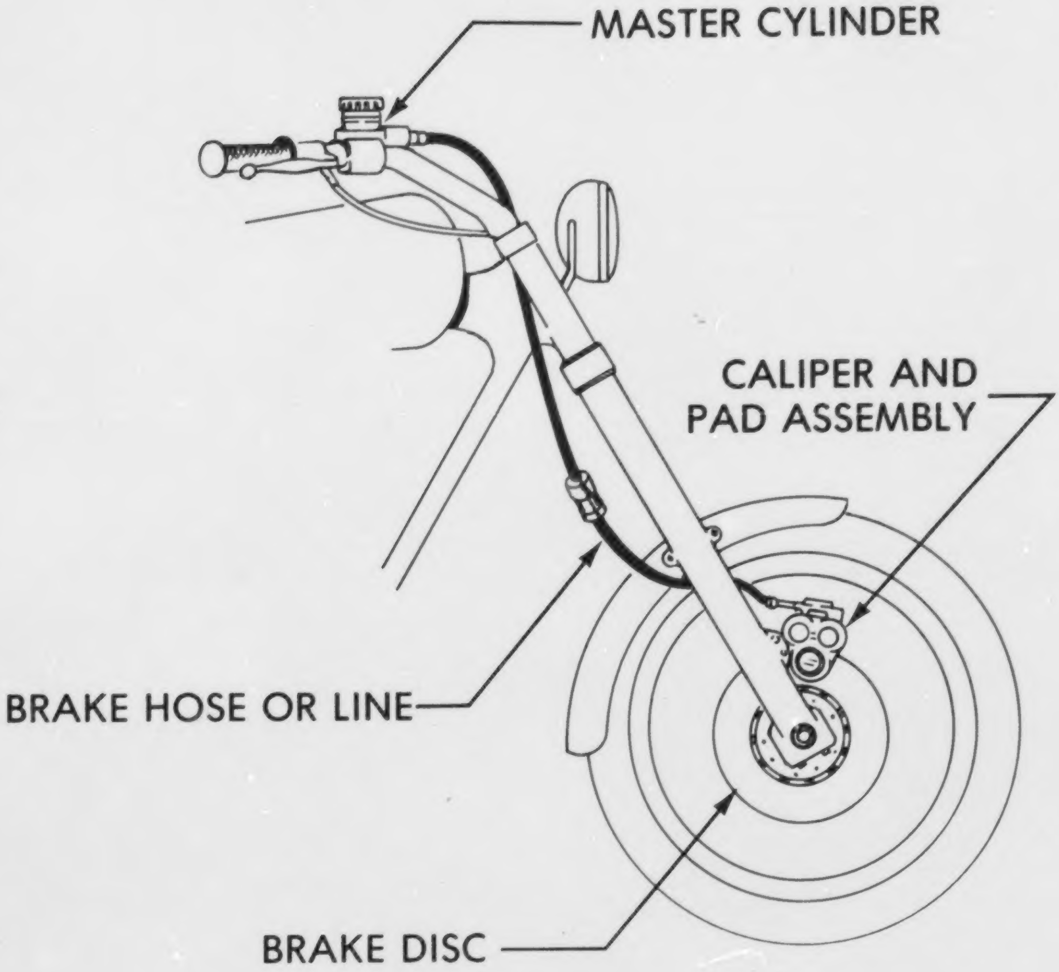
    2. Deflected piston seal returns to shape

        a. Pulls piston back slightly

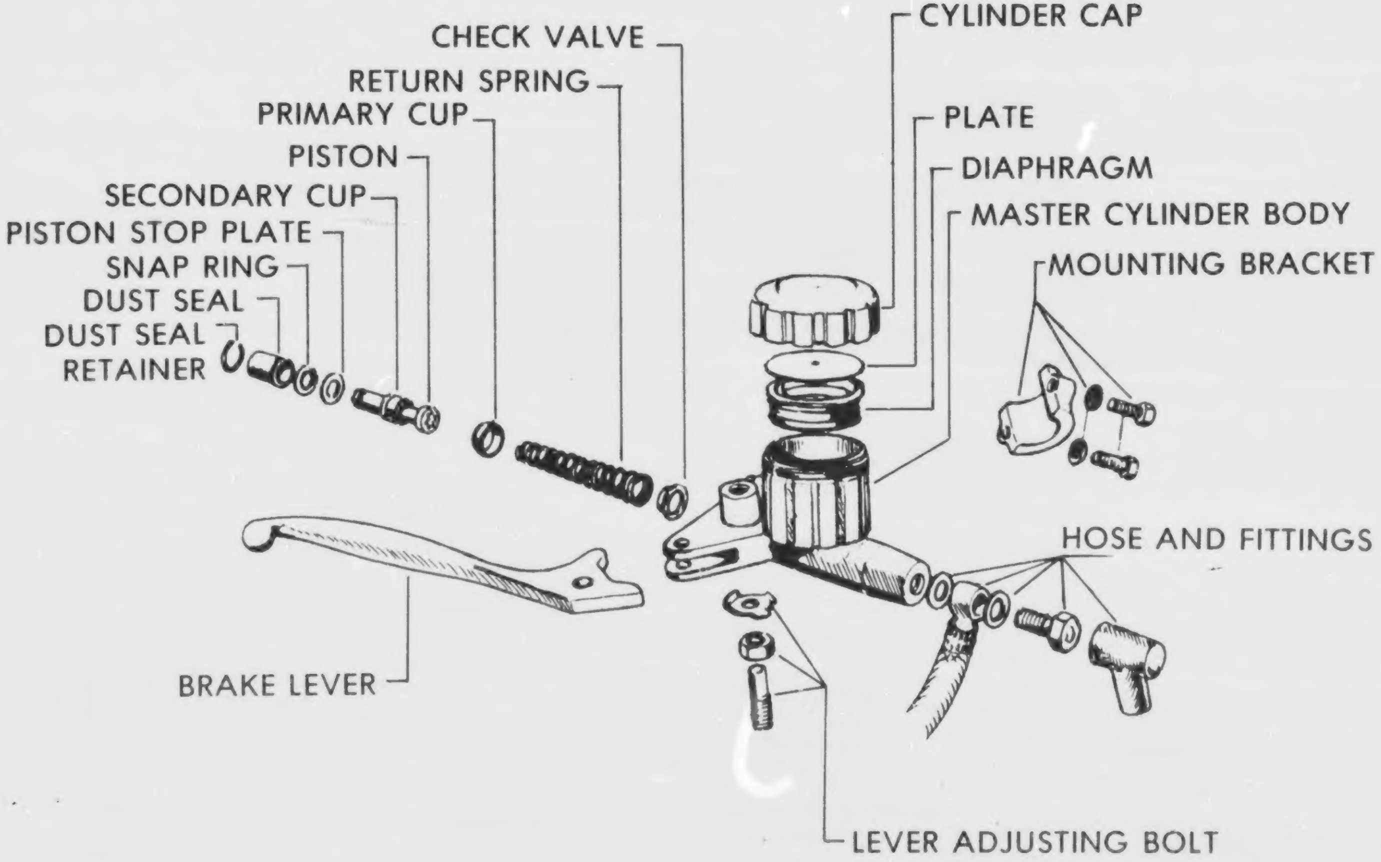
        b. Discontinues squeezing action of pads on disc

(NOTE: As pad wears, the piston slips past the seal and is not pulled back to the original position thus eliminating the need for periodic adjustment.)

# Parts of Hydraulic Disc Brake System


MASTER CYLINDER
CALIPER AND PAD ASSEMBLY
BRAKE HOSE OR LINE
BRAKE DISC

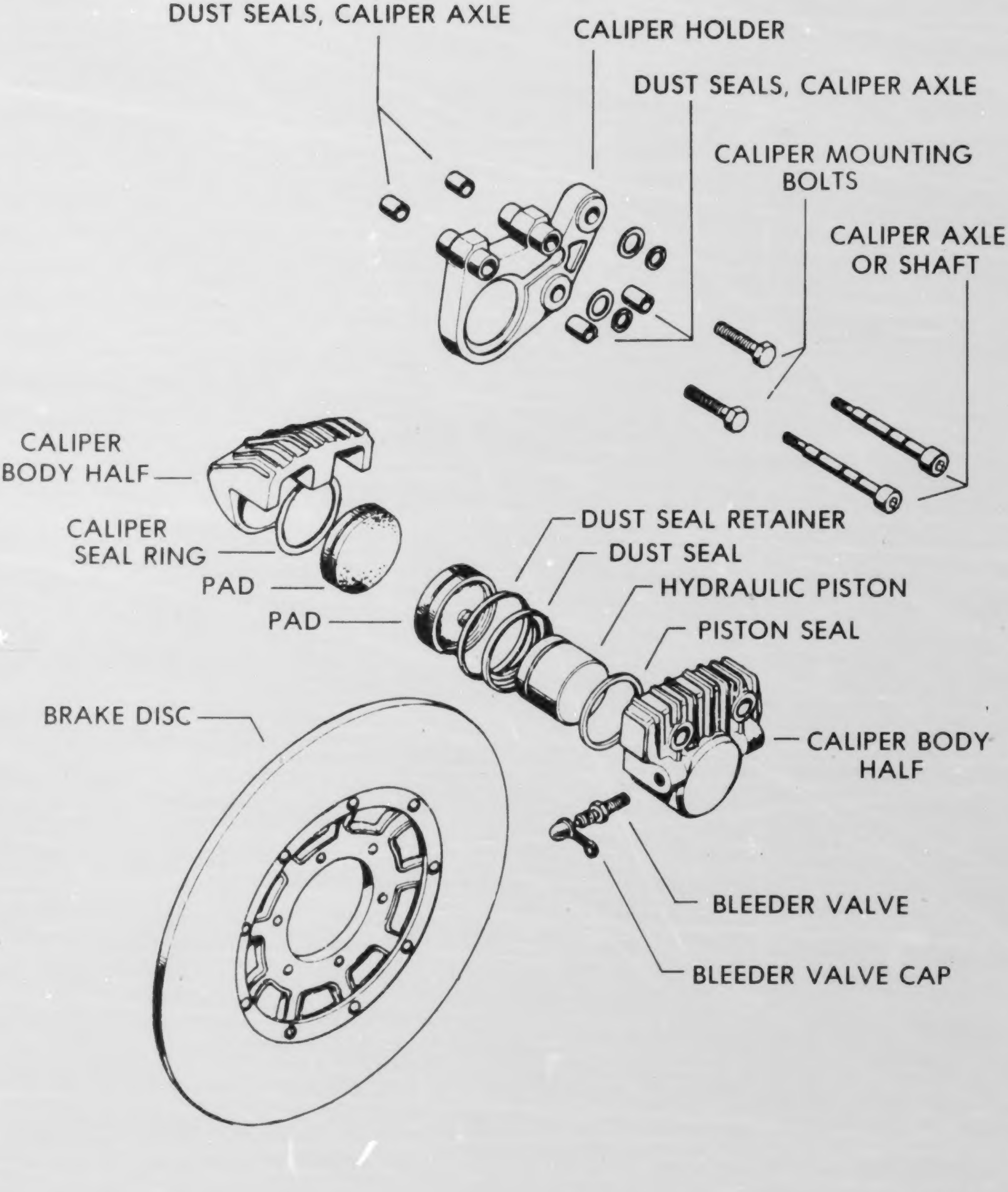
# Parts of Master Cylinder


CHECK VALVE
RETURN SPRING
PRIMARY CUP
PISTON
SECONDARY CUP
PISTON STOP PLATE
SNAP RING
DUST SEAL
DUST SEAL RETAINER
CYLINDER CAP
PLATE
DIAPHRAGM
MASTER CYLINDER BODY
MOUNTING BRACKET
HOSE AND FITTINGS
BRAKE LEVER
LEVER ADJUSTING BOLT

TM-2

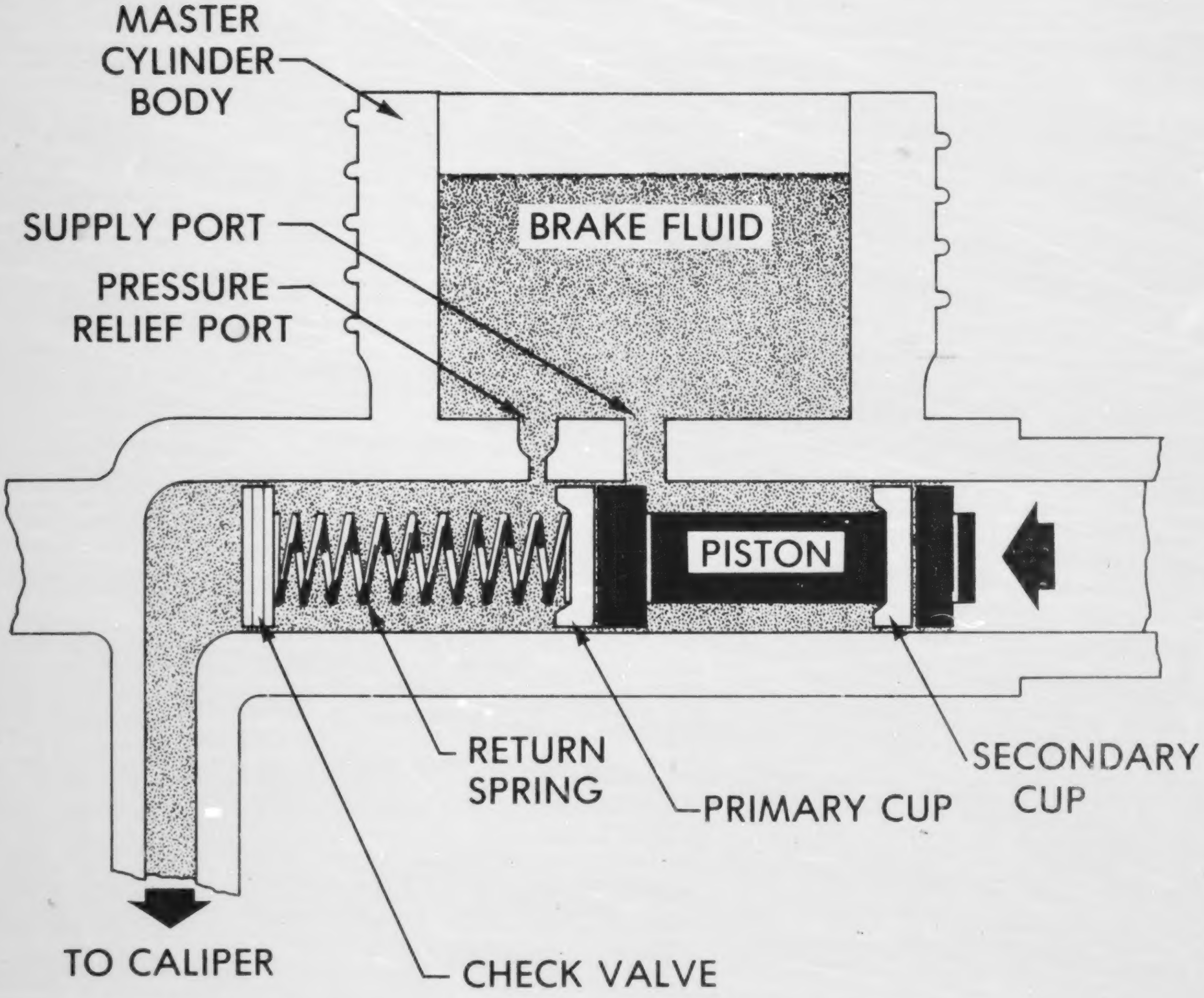
M - 41-A

# Parts of A Brake Caliper

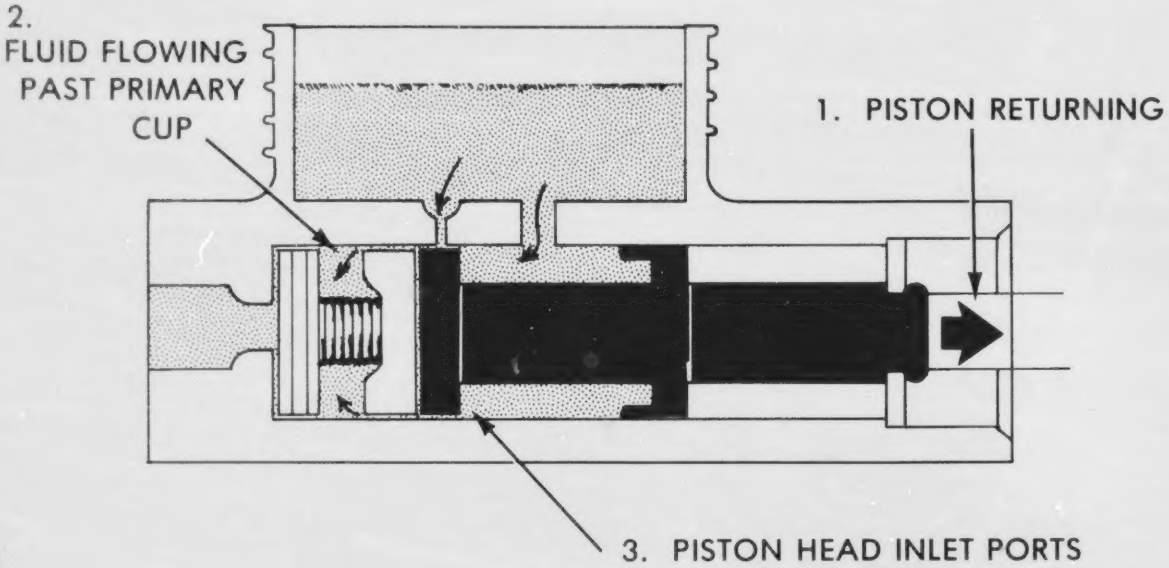

DUST SEALS, CALIPER AXLE
CALIPER HOLDER
DUST SEALS, CALIPER AXLE
CALIPER MOUNTING BOLTS
CALIPER AXLE OR SHAFT
CALIPER BODY HALF
CALIPER SEAL RING
PAD
PAD
DUST SEAL RETAINER
DUST SEAL
HYDRAULIC PISTON
PISTON SEAL
BRAKE DISC
CALIPER BODY HALF
BLEEDER VALVE
BLEEDER VALVE CAP

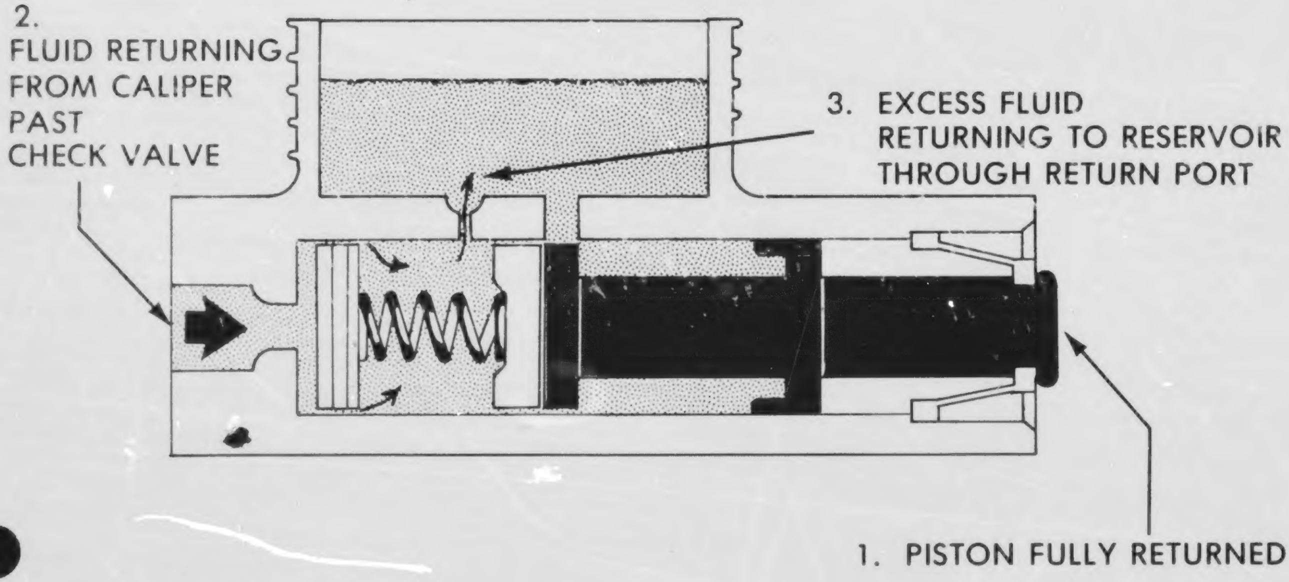
TM-3

# Operation of Master Cylinder Brake Application


MASTER CYLINDER BODY
SUPPLY PORT
PRESSURE RELIEF PORT
BRAKE FLUID
PISTON
RETURN SPRING
PRIMARY CUP
SECONDARY CUP
TO CALIPER
CHECK VALVE

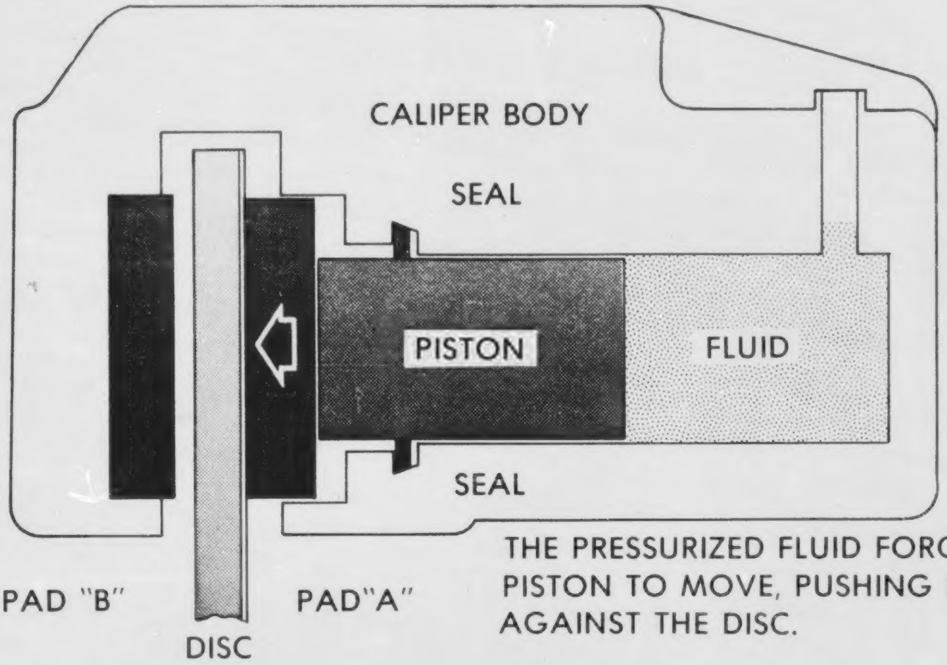
# Operation of Master Cylinder Brake Release


2.
FLUID FLOWING PAST PRIMARY CUP
1. PISTON RETURNING
3. PISTON HEAD INLET PORTS

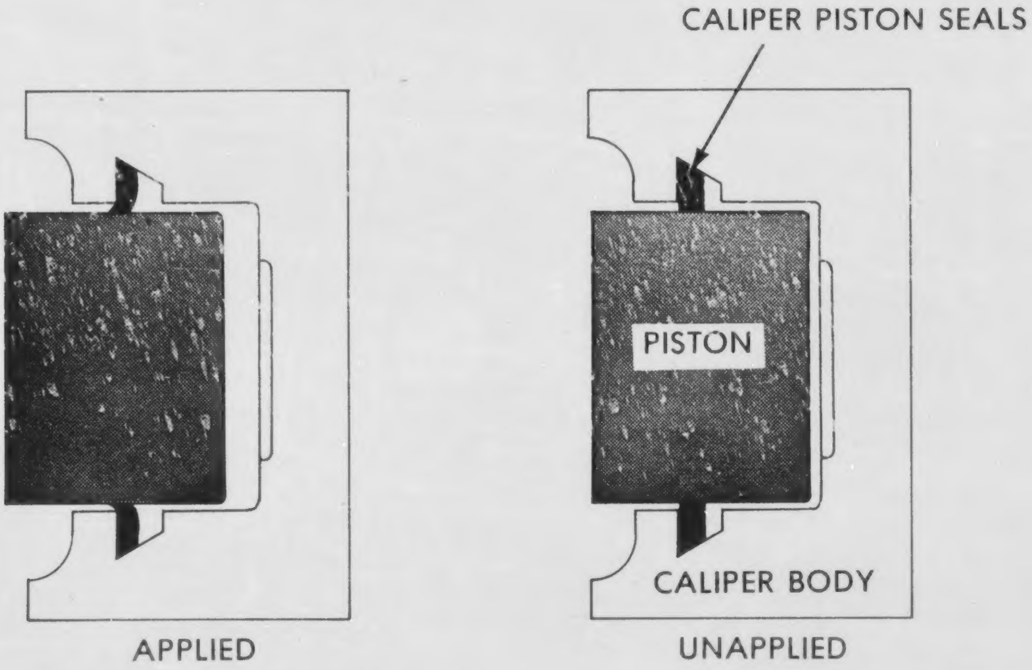

2.
FLUID RETURNING FROM CALIPER PAST CHECK VALVE
3. EXCESS FLUID RETURNING TO RESERVOIR THROUGH RETURN PORT
1. PISTON FULLY RETURNED

# Brake Caliper Application

## FIRST STAGE

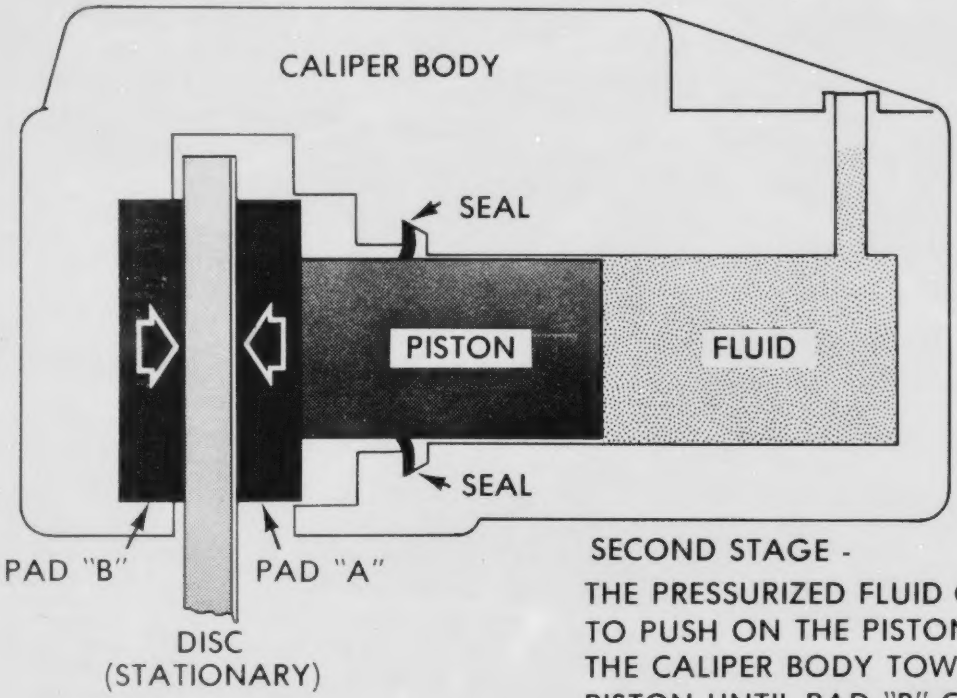

CALIPER BODY
SEAL
PISTON
FLUID
SEAL
PAD "B"
DISC
PAD"A"

THE PRESSURIZED FLUID FORCES THE PISTON TO MOVE, PUSHING PAD "A" AGAINST THE DISC.


CALIPER PISTON SEALS
PISTON
CALIPER BODY
APPLIED
UNAPPLIED

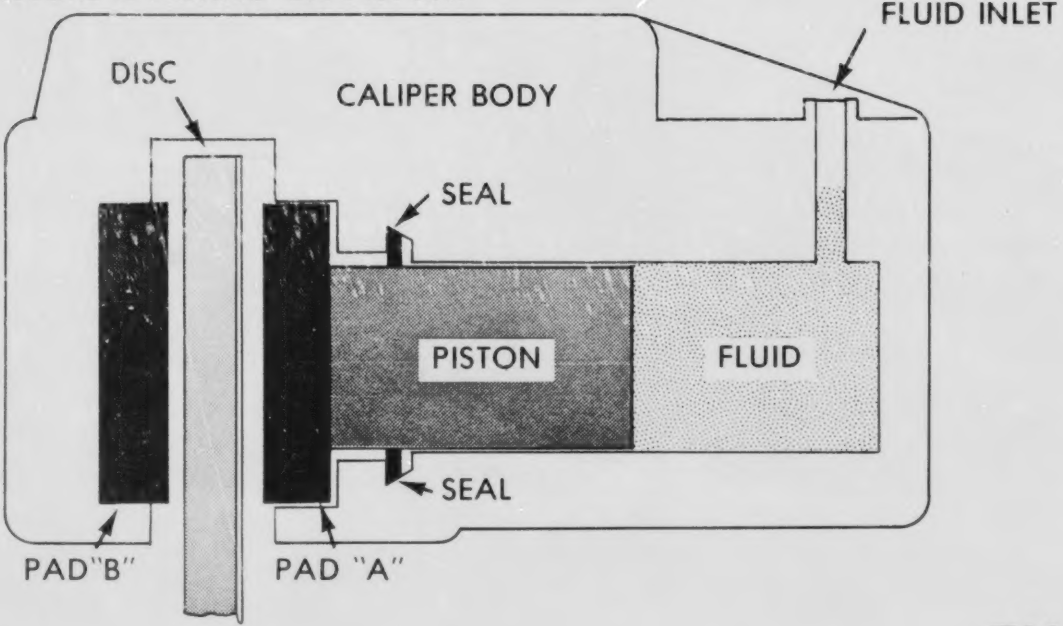
# Brake Caliper Application

## SECOND STAGE AND AT REST POSITION


CALIPER BODY
SEAL
PISTON
FLUID
SEAL
PAD "B"
PAD "A"
DISC
(STATIONARY)

SECOND STAGE -
THE PRESSURIZED FLUID CONTINUES TO PUSH ON THE PISTON, PULLING THE CALIPER BODY TOWARD THE PISTON UNTIL PAD "B" CONTACTS THE DISC.

REST POSITION -
BOTH PADS ARE BACK AWAY FROM DISC; NO PRESSURE IS ACTING ON PISTON.

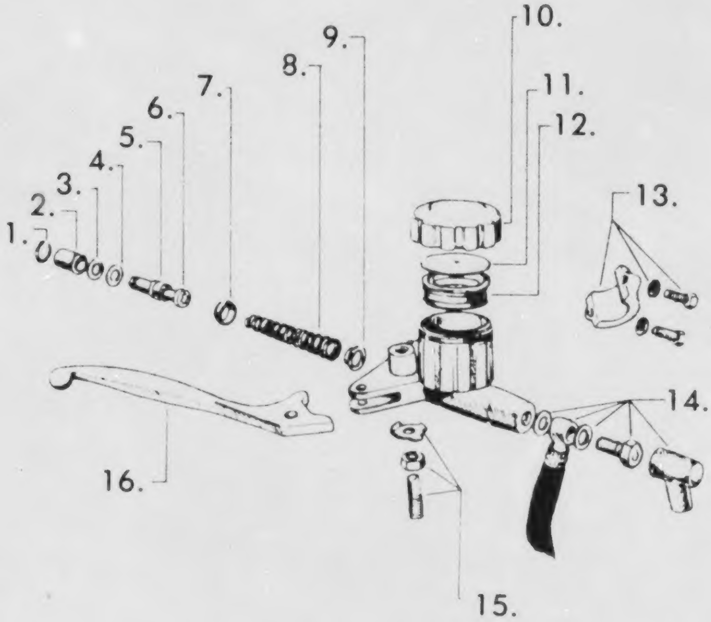

FLUID INLET
DISC
CALIPER BODY
SEAL
PISTON
FLUID
SEAL
PAD"B"
PAD "A"

M - 53-A

## HYDRAULIC DISC BRAKE SYSTEMS
## UNIT II

### ASSIGNMENT SHEET #1--IDENTIFY THE MASTER CYLINDER PARTS

Identify each of the labeled parts correctly by writing the name in the space provided.


1.
2.
3.
4.
5.
6.
7.
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9.
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11.
12.
13.
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15.
16.

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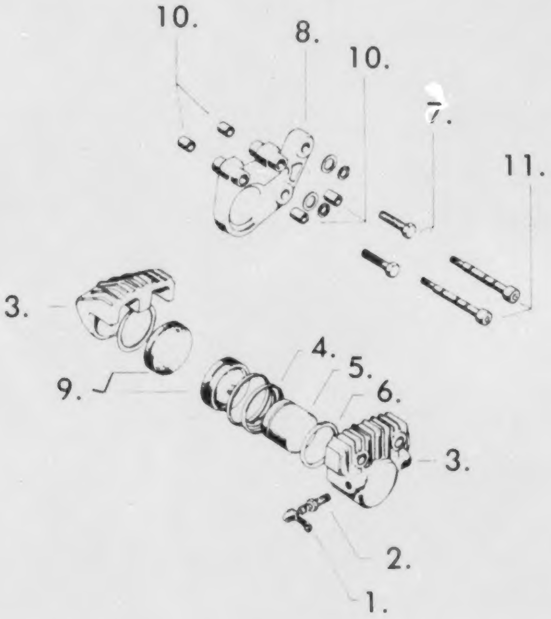
11.
12.
13.
14.
15.
16.

## HYDRAULIC DISC BRAKE SYSTEMS
## UNIT II

## ASSIGNMENT SHEET #2--IDENTIFY THE BRAKE CALIPER PARTS

Identify each of the labeled parts correctly by writing the name in the space provided.



1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

11.

## HYDRAULIC DISC BRAKE SYSTEMS
## UNIT II

## ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. Dust seal retainer
2. Dust seal
3. Snap ring
4. Piston stop plate
5. Piston
6. Secondary cup
7. Primary cup
8. Return spring
9. Check valve
10. Cylinder cap
11. Plate
12. Diaphragm
13. Mounting bracket
14. Hose and fittings
15. Lever adjusting bolt
16. Brake lever

Assignment Sheet #2

1. Bleeder valve cap
2. Bleeder valve
3. Caliper body halves
4. Piston seal
5. Hydraulic piston
6. Dust seal
7. Caliper mounting bolt
8. Caliper holder
9. Pads
10. Dust seals, caliper axle
11. Caliper axle or shaft

# HYDRAULIC DISC BRAKE SYSTEMS
## UNIT II

## JOB SHEET #1--REMOVE, DISASSEMBLE, INSPECT, REASSEMBLE, AND REPLACE A MASTER CYLINDER

I. Tools and materials

   A. Safety glasses

   B. Metric combination wrench set

   C. Hand tool assortment

   D. Drain pan

   E. Brake cylinder hone

   F. New hydraulic brake fluid

   G. Appropriate service manual

   H. New replacement parts

II. Procedure

   A. Remove the brake light switch from master cylinder, if so equipped

   B. Disconnect hydraulic brake line from master cylinder

   C. Catch brake fluid in drain pan

   (NOTE: Be sure to protect paint and other parts with a shop cloth.)

   D. Remove master cylinder mounting bolts

   E. Remove cylinder from motorcycle for disassembly at workbench

   F. Empty remaining brake fluid into drain pan

   G. Disassemble master cylinder

      1. Remove the brake lever

      2. Remove the dust boot stopper, boot plate, and boot

      3. Remove the snap ring using suitable snap ring pliers

      4. Withdraw the piston stop plate, piston and secondary cup, primary cup, return spring, and check valve

## JOB SHEET #1

5. Wash all parts in new brake fluid

   (NOTE: Never use gasoline or petroleum to wash parts because the rubber parts can be damaged.)

H. Inspect all parts, especially the master cylinder bore

I. Lightly hone master cylinder bore to remove minor scratches or other imperfections

(NOTE: Be sure to clean cylinder bore area thoroughly after honing.)

J. Check diameter of bore

(NOTE: Compare with service manual specifications.)

K. Inspect piston for scratches or wear

L. Reassemble master cylinder using new parts as necessary in the following order:

1. Check valve
2. Return spring
3. Primary cup with lip facing outlet part of cylinder body

   (NOTE: Be especially careful when installing the primary cup.)

4. Piston and secondary cup
5. Stop plate
6. Snap ring
7. Dust boot
8. Boot plate
9. Boot stopper

(NOTE: Usually all internal parts are replaced; often a standard repair kit can be obtained.)

M. Coat all internal parts especially primary and secondary cups with new, clean brake fluid

N. Remount the master cylinder to the motorcycle and connect the brake line and the brake light switch

O. Fill reservoir with new, clean fluid

## HYDRAULIC DISC BRAKE SYSTEMS
## UNIT II

### JOB SHEET #2--REMOVE, DISASSEMBLE, INSPECT, AND REASSEMBLE A BRAKE CALIPER

I. Tools and materials

   A. Safety glasses

   B. Metric combination wrenches and hex keys

   C. Hand tool assortment

   D. Drain pan

   E. Inside micrometer

   F. Outside micrometer

   G. New hydraulic brake fluid

   H. Axle grease

   I. Brake pad grease

   J. Appropriate service manual

   K. New replacement parts

II. Procedure

   A. Disconnect brake line from caliper body, and catch fluid in drain pan

   B. Remove caliper mounting bolts

   C. Remove the caliper assembly from mounting

   D. Disassemble the caliper

      1. Unscrew the caliper axle bolts and separate the caliper bodies

      2. Remove the brake pads

      3. Remove the piston boot and piston

         (NOTE: The piston can be removed by using compressed air and by carefully applying pressure into the brake line opening.)

## JOB SHEET #2

4. Wash all parts, except the pads, in clean brake fluid

   (NOTE: Never use gasoline or petroleum to wash parts because the rubber parts can be damaged.)

E. Inspect and measure the caliper piston bore

F. Inspect and measure the piston

G. Inspect pads and wear limit marking on the pads

   (NOTE: The wear limit marking is usually a line marked on the circumference of the pad.)

H. Reassemble the calipers

   1. Install piston seal in caliper body, using plenty of brake fluid on the seal and inner surface of the cylinder

      (NOTE: Be sure piston seal is not twisted in its groove.)

   2. Coat the piston with brake fluid and push it slowly into the cylinder

      (NOTE: Be careful not to damage the piston seal.)

   3. Apply special pad grease to the outer circumference and back side of pads

      (NOTE: Never put grease on disc side of pad.)

   4. Install pads into caliper body halves

   5. Apply axle grease to caliper axles and reinstall axles using new dust seals and o-rings

I. Reinstall caliper assembly on motorcycle, torquing all bolts to specifications

J. Reconnect brake line

# HYDRAULIC DISC BRAKE SYSTEM
# UNIT II

## JOB SHEET #3 BLEED THE HYDRAULIC DISC BRAKE SYSTEM

I. Tools and materials

   A. Safety glasses

   B. New hydraulic brake fluid

   C. Metric wrench to fit bleeder valve

   D. Bleeder tube

   (NOTE: A transparent tube is best because air bubbles can be observed during the bleeding process.)

   E. Clean container partially filled with clean brake fluid

II. Procedure

   A. Fill master cylinder with new brake fluid

   B. Connect bleeder tube to bleeder valve on caliper

   C. Submerge other end of tube into partially filled container of fluid

   D. Build up pressure in hydraulic system by squeezing the hand lever rapidly several times and holding the lever tightly

   E. While holding pressure on the lever, open the bleeder valve about 1/2 turn (Figure 1)

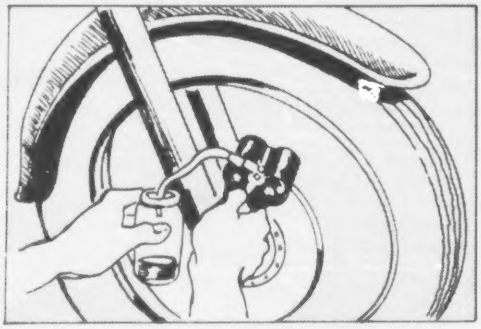


**FIGURE 1**

   F. When handle goes down, hold it down until bleeder screw is closed

## JOB SHEET #3

G. Repeat pumping up hydraulic pressure, while opening and closing bleeder valve until all air has been expelled

(NOTE: Check fluid level in master cylinder frequently throughout bleeding process.)

H. Tighten bleeder valve

I. Remove hose

J. Install bleeder valve dust cap

K. Check fluid level in master cylinder and fill to proper level

# HYDRAULIC DISC BRAKE SYSTEMS
## UNIT II

## JOB SHEET #4--INSPECT AND CHECK THE BRAKE DISC

I. Tools and materials

   A. Safety glasses

   B. Motorcycle stand or blocks

   C. 0" - 1" micrometer

   D. Dial indicator

   E. Appropriate service manual

II. Procedure

   A. Raise front wheel of motorcycle using stand or blocks

   B. Inspect friction surface of disc for wear and scoring

   C. Measure thickness of disc on the worn portion with micrometer, and compare readings with specifications in service manual (Figure 1)

   (NOTE: Take measurements 1/2" to 1" from outer edge at several points around the disc.)

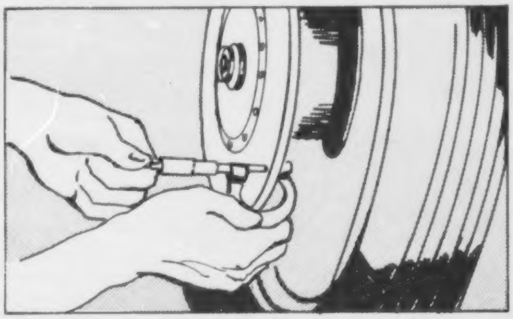


FIGURE 1

   D. Check runout of disc (Figure 2)

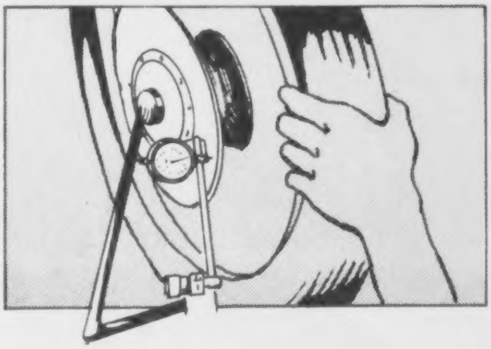


FIGURE 2

## JOB SHEET #4

1. Mount dial indicator so that contact button contacts the outermost edge of the disc
2. Preload the dial indicator
3. Set scale to 0"
4. Rotate front wheel and disc slowly
5. Observe total runout of disc
6. Compare readings with specifications in service manual

   (NOTE: If runout is excessive, determine first that the wheel bearings and axle are not at fault.)

## HYDRAULIC DISC BRAKE SYSTEMS
## UNIT II

## TEST

1. Match the terms on the right to the correct definitions.

_____a. Condition caused by heat or moisture that decreases friction and the resulting braking power of the system

_____b. Hard slick finish that forms on brake lining due to heat and friction

_____c. Temperature at which fluids begin to vaporize

_____d. Resistance to relative movement between two bodies in contact

_____e. Braking system utilizing a caliper which compresses brake pads against a circular disc

_____f. Basic property of fluids which means they cannot be reduced in volume by pressure

_____g. Basic principle of hydraulics whereby the force applied to pressurize a fluid is increased in direct proportion to the difference in surface area of the two pistons

_____h. Process of expelling air from the hydraulic system

1. Disc brakes
2. Friction
3. Force multiplication
4. Brake lining glaze
5. Noncompressible
6. Brake bleeding
7. Boiling point
8. Brake fade

2. List the advantages of the hydraulic disc brake system.

a.

b.

c.

d.

e.

3. Name the main parts of a hydraulic disc brake system.

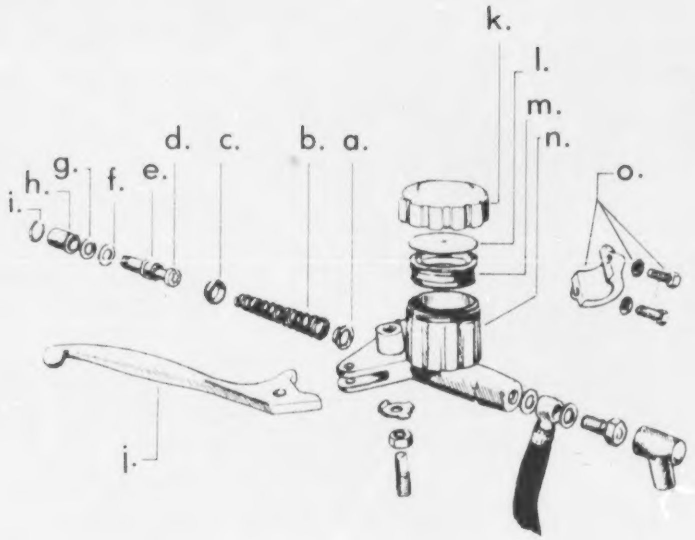
a.

b.

c.

d.

4. Identify the parts of the master cylinder.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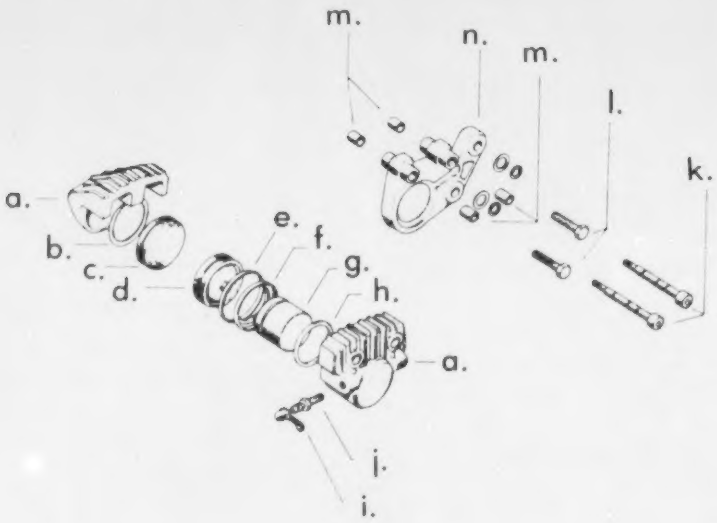
5. Identify the parts of the brake caliper.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n.

6. Discuss the care and handling of hydraulic brake fluid.

7. Describe the operation of the master cylinder.

8. Describe the operation of the brake caliper.

9. Demonstrate the ability to:

   a. Remove, disassemble, inspect, reassemble, and replace a master cylinder.

   b. Remove, disassemble, inspect, and reassemble a brake caliper.

   c. Bleed the hydraulic disc brake system.

   d. Inspect and check the brake disc.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

# HYDRAULIC DISC BRAKE SYSTEMS
## UNIT II

## ANSWERS TO TEST

1. a. 8
   b. 4
   c. 7
   d. 2
   e. 1
   f. 5
   g. 3
   h. 6

2. a. Minimum brake fade due to greater heat dissipation
   b. Greater braking power
   c. Greater reliability
   d. Self-adjusting
   e. Easier to inspect for lining wear

3. a. Master cylinder
   b. Brake hoses or lines
   c. Caliper and pad assembly
   d. Brake disc

4. a. Check valve
   b. Return spring
   c. Primary cup
   d. Secondary cup
   e. Piston
   f. Piston stop plate
   g. Snap ring
   h. Dust seal
   i. Dust seal retainer
   j. Brake lever
   k. Cylinder cap
   l. Plate
   m. Diaphragm
   n. Master cylinder body
   o. Mounting bracket

5. a. Caliper body halves
   b. Caliper seal ring
   c. Pads
   d. Brake disc
   e. Dust seal retainer
   f. Dust seal
   g. Hydraulic piston
   h. Piston seal
   i. Bleeder valve cap
   j. Bleeder valve
   k. Caliper axle or shaft
   l. Caliper mounting bolts
   m. Dust seals, caliper axle
   n. Caliper holder

6. Discussion should include:
   a. Keep hydraulic brake fluid clean and free of moisture
   b. Do not mix hydraulic brake fluids having different bases
   c. Do not reuse old brake fluid
   d. Do not spill brake fluid on painted surfaces or gauges

7. Description should include:
   a. Operator compresses brake lever
      1) Piston and primary and secondary cups move inward
      2) Fluid is trapped and pressurized as cups seal off return port
      3) Fluid under pressure is forced through check valve and brake lines to the caliper
      4) Return spring in master cylinder is being compressed throughout this operation
   b. Operator releases brake lever
      1) Piston and cups are pushed back by compressed return spring
      2) Piston moves back faster than fluid returns from caliper creating a void in front of piston
      3) Void in front of secondary cup is filled by
         a) Fluid flowing in from reservoir
         b) Fluid from behind piston flowing through small holes in piston past primary cup

    4) Fluid returning from caliper
        a) Passes check valve
        b) Passes through return port to reservoir

8. Description should include:
    a. Operator compresses brake lever
        1) Fluid under pressure pushes piston and applies force to pad
        2) Piston movement causes seal to deform slightly
        3) Brake pads contacts brake disc
            a) Caliper body reacts by sliding on caliper axle
            b) Caliper's sliding action pulls second pad into contact with brake disc
            c) Brake disc is clamped between pads to create braking friction
    b. Operator releases brake lever
        1) Fluid pressure is eliminated
        2) Deflected piston seal returns to shape
            a) Pulls piston back slightly
            b) Discontinues squeezing action of pads on disc

9. Performance skills evaluated to the satisfaction of the instructor

# CENTRIFUGAL CLUTCHES
## UNIT I

## UNIT OBJECTIVE

After completion of this unit, the student should be able to identify the parts of a centrifugal clutch, describe its construction, and discuss its operation. The student should also be able to remove, service, and replace a centrifugal clutch. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with centrifugal clutches to the correct definitions.
2. Identify the parts of a centrifugal clutch.
3. List the types of centrifugal clutch actuating weights.
4. Describe the construction of a centrifugal clutch.
5. Discuss the operation of a centrifugal clutch.
6. Select causes of specific clutch failures.
7. Demonstrate the ability to:
    a. Remove and disassemble a centrifugal clutch.
    b. Inspect and measure the parts of a centrifugal clutch.
    c. Reassemble and replace a centrifugal clutch.
    d. Adjust a centrifugal clutch.

## CENTRIFUGAL CLUTCHES
## UNIT I

### SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Construct a cutaway or mock-up of a centrifugal clutch.

   G. Demonstrate and discuss the procedures outlined in the job sheets.

   H. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheets.

   D. Complete activities assigned by instructor.

   E. Take test.

### INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Parts of a Centrifugal Clutch

      2. TM 2--Roller Centrifugal Clutch Weight

3. TM 3--Pivot Centrifugal Clutch Weight

4. TM 4--Steel Ball Centrifugal Clutch Weight

5. TM 5--Clutch Release Mechanism

D. Job sheets

1. Job Sheet #1--Remove and Disassemble a Centrifugal Clutch

2. Job Sheet #2--Inspect and Measure the Parts of a Centrifugal Clutch

3. Job Sheet #3--Reassemble and Replace a Centrifugal Clutch

4. Job Sheet #4--Adjust a Centrifugal Clutch

E. Test

F. Answers to test

II. References:

A. *Chilton's New Motorcycle Troubleshooting Guide*. Radnor, Pennsylvania: Chilton Book Co., 1973.

B. *Motorcycle Service Manual.* Vol. 1. 3rd ed. Kansas City, Missouri: Technical Publications Division/Intertec Publishing Corp., 1972.

C. *Honda 90 Service Manual.* Honda Motor Co., Ltd.

D. *Motorcycle Systems Training Manual-Motorcycle Power Train.* Kawasaki Motors Corp., 1973.

E. Glenn, Harold T. *Glenn's Honda Single Cylinder Repair and Tune-Up Guide.* New York: Crown Publishers, Inc., 1968.

# CENTRIFUGAL CLUTCHES
## UNIT I

## INFORMATION SHEET

I. Terms and definitions

   A. Centrifugal force--Force which tends to move a body away from its center of rotation and increases as the speed of rotation increases

   B. Power flow--Transfer of power, in proper sequence, from one unit to another

   C. Friction disc--Metal plate that has friction lining bonded to it and is the driven component of the clutch

   D. Clutch plates--Smooth steel plates that are connected to the drive plate and provide a friction surface for the friction discs

   E. Drive plate--Heavy steel plate connected to the crankshaft that drives the clutch

   F. Primary drive gear--First gear in the power flow driven by the clutch

   G. Centrifugal weights--Weights that generate the necessary force to apply the clutch

II. Parts of centrifugal clutch (Transparency 1)

   A. Clutch plate retaining ring

   B. Clutch plates

   C. Friction discs

   D. Clutch plate return spring

   E. Primary drive gear snap ring

   F. Primary drive gear

   G. Clutch hub

   H. Clutch hub guide or bushing

   I. Centrifugal weights

   J. Drive plate

## INFORMATION SHEET

- K. Clutch cover return spring
- L. Clutch cover
- M. Clutch damper spring
- N. Bearing shell
- O. Clutch release ball bearing
- P. Oil guide and thrust plate
- Q. Clutch camplate
- R. Release lever
- S. Adjusting bolt and locknut
- T. Transmission shift shaft

III. Types of centrifugal clutch actuating weights (Transparencies 2, 3, and 4)

- A. Roller
- B. Pivot
- C. Steel ball

IV. Construction of centrifugal clutch

- A. Clutch drive plate, clutch plates, and clutch cover are connected and all rotate together
- B. Friction discs connected to and rotate with clutch hub
- C. Springs hold friction discs and plates apart
- D. Centrifugal weights apply pressure to create friction between plates and discs
- E. Override system
  - 1. Lever
  - 2. Camplate bearing
  - 3. Clutch cover springs

## INFORMATION SHEET

- F. Key factors in construction
  - 1. Centrifugal weights
    - a. Correct size
    - b. Correct weight
  - 2. Drive plate
    - a. Alignment
    - b. Wear in the area of the centrifugal weights

V. Operation of centrifugal clutch

- A. Low RPM (1800 RPM and less)
  - 1. Centrifugal force acting on weights is not enough to overcome return springs that hold clutch plates and friction discs apart
  - 2. No friction
  - 3. No transmission of power
- B. Medium and high RPM
  - 1. Centrifugal force causes weights to move outward
  - 2. Weights move along inclined ramps
    - a. Compress return springs
    - b. Clutch plates and friction discs come together
    - c. Friction causes friction discs to rotate
    - d. Power is transmitted to clutch hub and on to primary drive gear

      (NOTE: A screw spline on some clutch hubs, notably Honda, helps to engage the clutch and keep it engaged when using engine compression for breaking.)
- C. Shifting at high RPM (Transparency 5)
  - 1. Lever attached to foot pedal rotates camplate
  - 2. Camplate exerts force on clutch release ball bearing

## INFORMATION SHEET

3. Bearing pushes clutch cover inward against spring tension
4. Plates and discs separate to interrupt flow of power even though centrifugal force is still acting upon the weights
5. Shifting can be accomplished smoothly with no power being transmitted

VI. Causes of clutch failures

A. Clutch will not engage

1. Centrifugal weights not working properly
2. Worn or broken friction discs
3. Clutch plate retaining ring broken or missing
4. Clutch cover return springs broken or missing
5. Improper adjustment of gear change mechanism

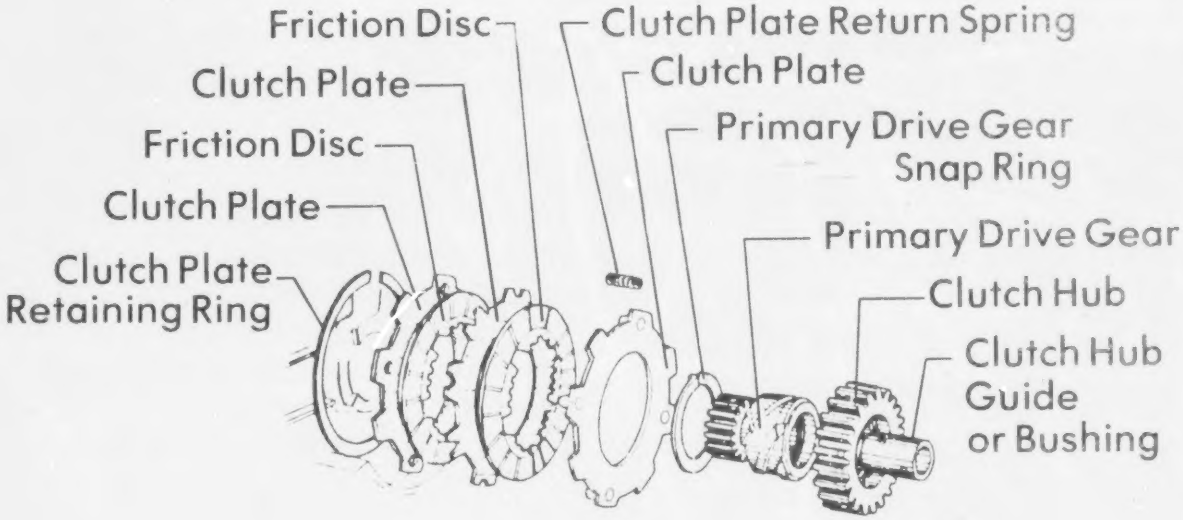
B. Clutch will not disengage

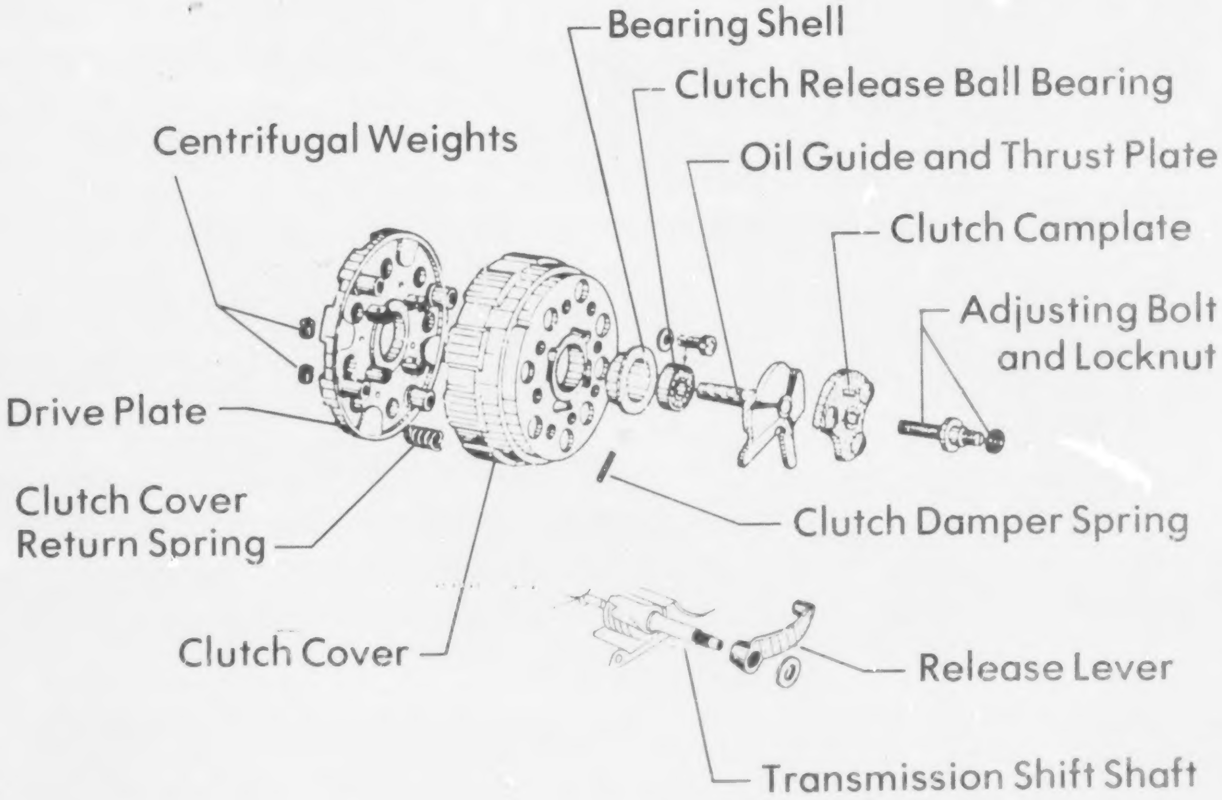
1. Centrifugal weights stuck in outward position
2. Weak, broken, or missing clutch return springs
3. Engine idle RPM too high
4. Binding between discs and plates

C. Clutch will not disengage while shifting

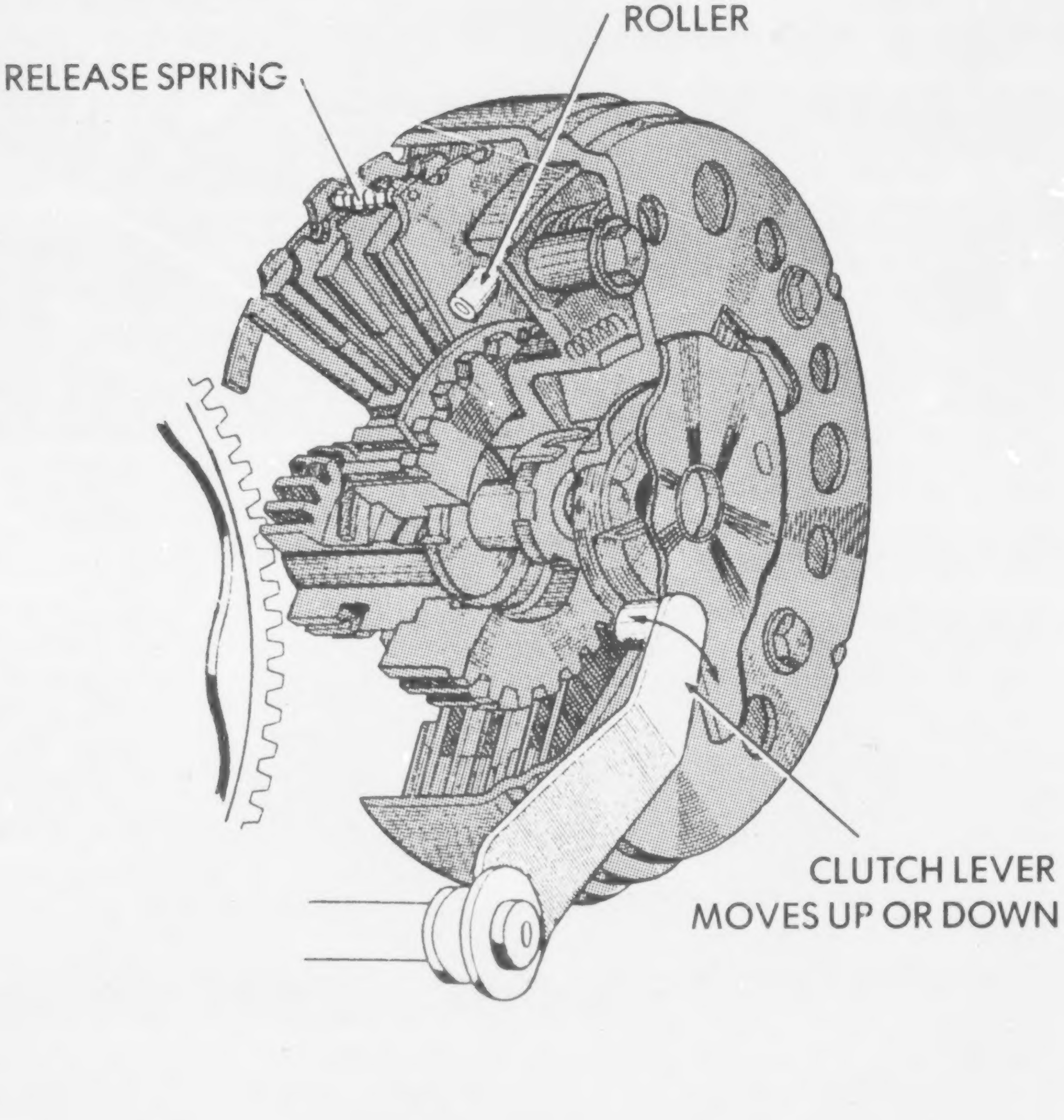
1. Faulty release mechanism
2. Improper adjustment of gear change mechanism
3. Slippage between shift spindle and release lever
4. Twisted, bent, or broken shift shaft

# PARTS OF A CENTRIFUGAL CLUTCH

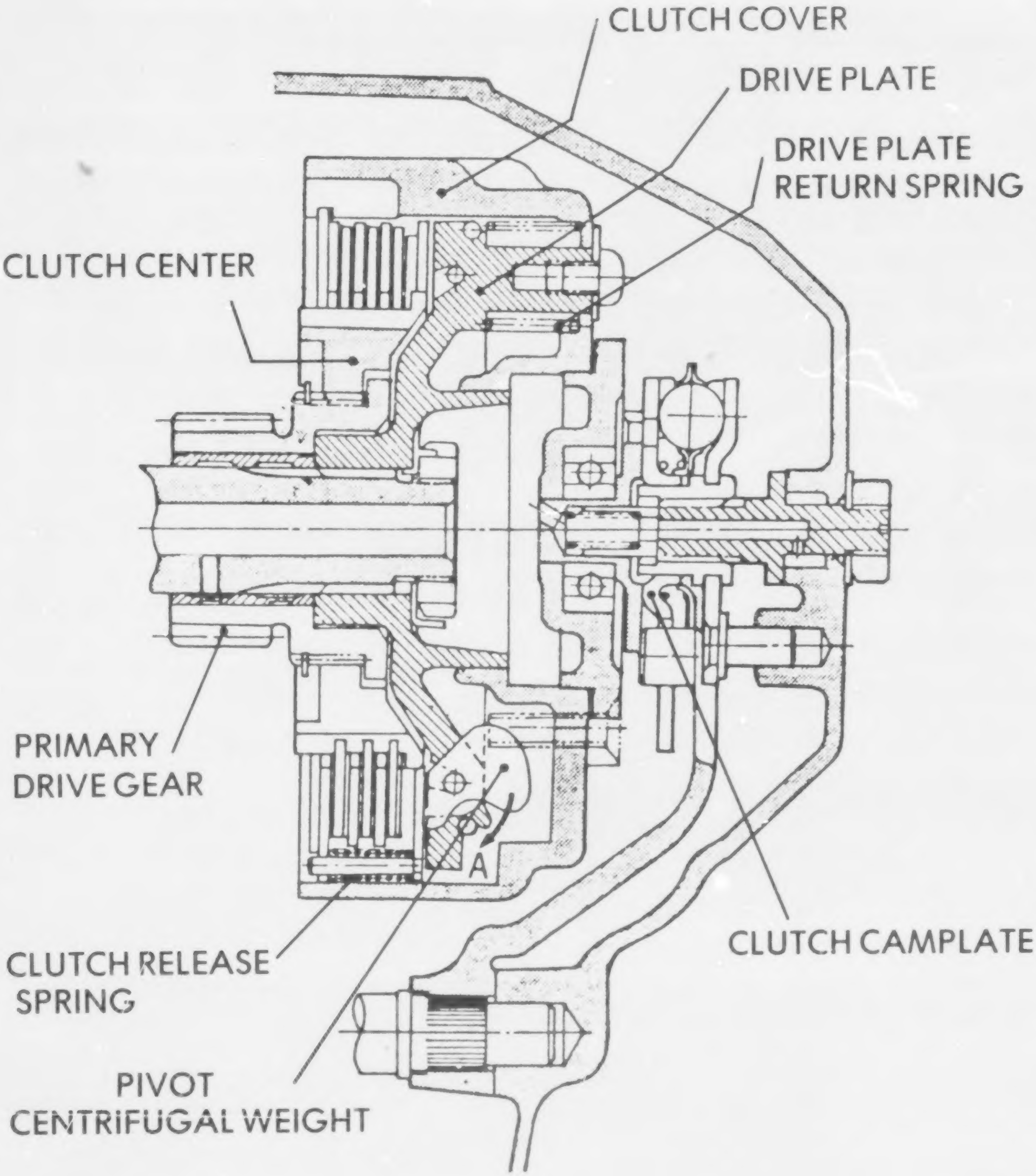

Friction Disc
Clutch Plate
Friction Disc
Clutch Plate
Clutch Plate Retaining Ring
Clutch Plate Return Spring
Clutch Plate
Primary Drive Gear Snap Ring
Primary Drive Gear
Clutch Hub
Clutch Hub Guide or Bushing


Centrifugal Weights
Drive Plate
Clutch Cover Return Spring
Clutch Cover
Bearing Shell
Clutch Release Ball Bearing
Oil Guide and Thrust Plate
Clutch Camplate
Adjusting Bolt and Locknut
Clutch Damper Spring
Release Lever
Transmission Shift Shaft

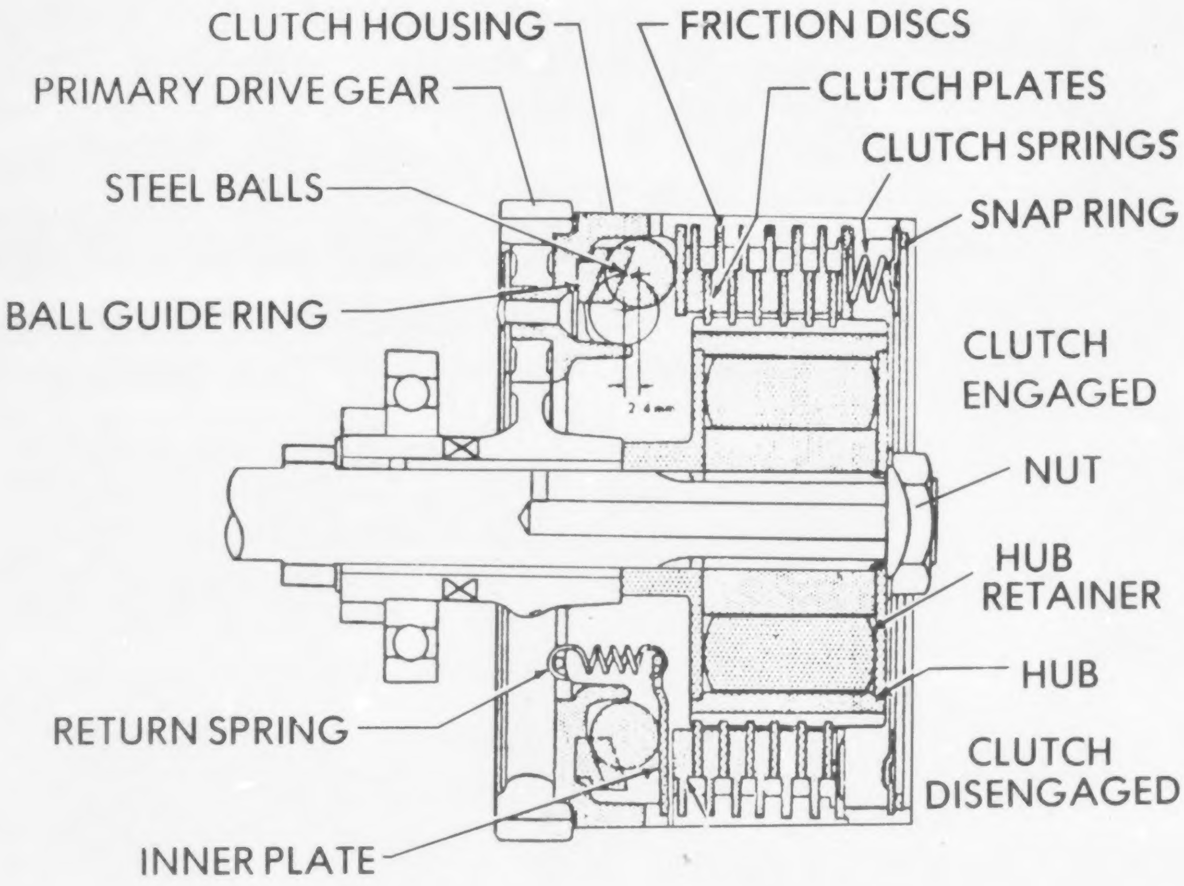
# ROLLER CENTRIFUGAL CLUTCH WEIGHT


ROLLER
RELEASE SPRING
CLUTCH LEVER
MOVES UP OR DOWN

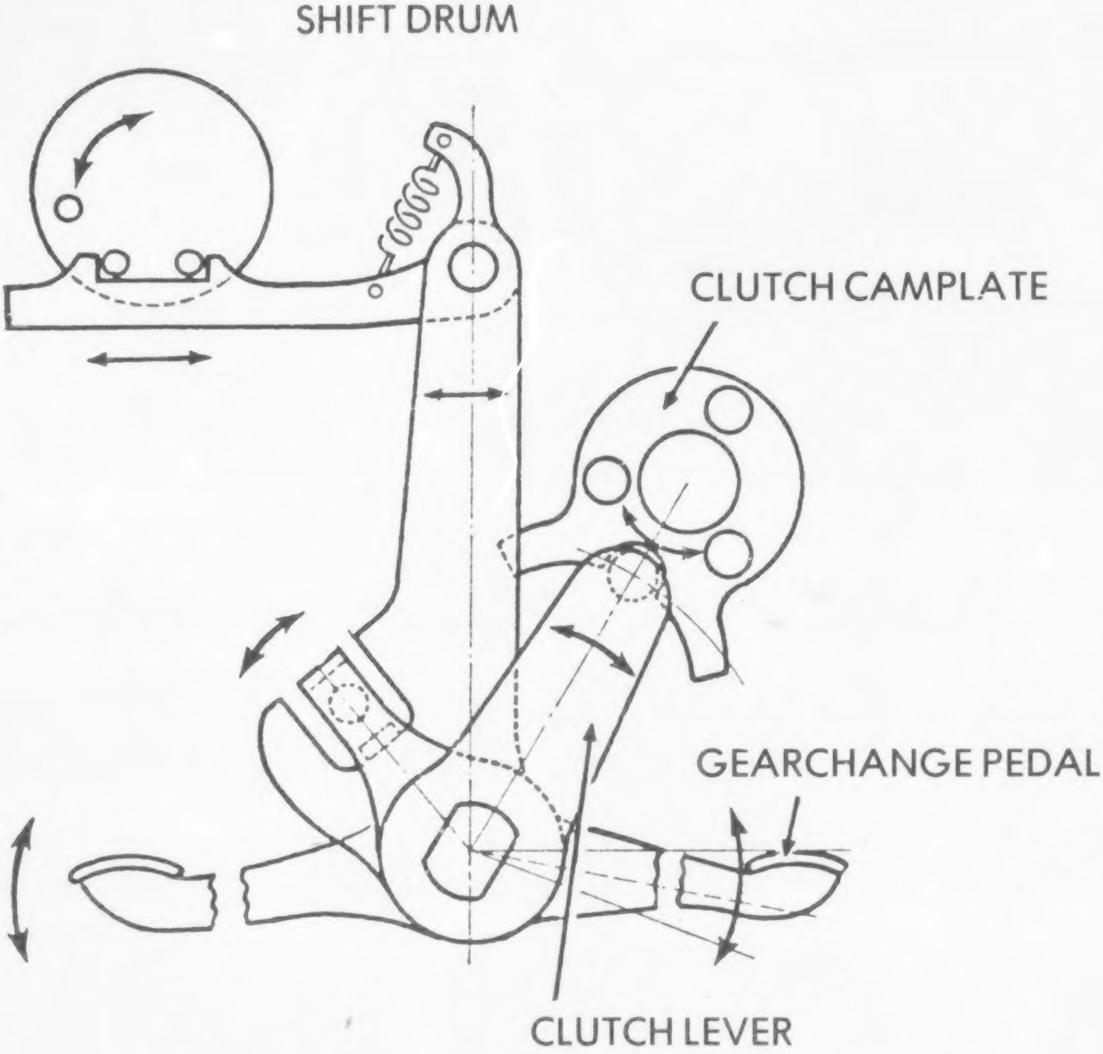
# PIVOT CENTRIFUGAL CLUTCH WEIGHT


CLUTCH COVER
DRIVE PLATE
DRIVE PLATE RETURN SPRING
CLUTCH CENTER
PRIMARY DRIVE GEAR
A
CLUTCH CAMPLATE
CLUTCH RELEASE SPRING
PIVOT CENTRIFUGAL WEIGHT

# STEEL BALL CENTRIFUGAL CLUTCH WEIGHT


CLUTCH HOUSING
FRICTION DISCS
PRIMARY DRIVE GEAR
CLUTCH PLATES
CLUTCH SPRINGS
STEEL BALLS
SNAP RING
BALL GUIDE RING
CLUTCH ENGAGED
2.4 mm
NUT
HUB RETAINER
HUB
RETURN SPRING
CLUTCH DISENGAGED
INNER PLATE

# CLUTCH RELEASE MECHANISM


SHIFT DRUM
CLUTCH CAMPLATE
GEARCHANGE PEDAL
CLUTCH LEVER

Operation of the clutch and gearchange levers on the automatic clutch machines.

# CENTRIFUGAL CLUTCHES
## UNIT I

## JOB SHEET #1--REMOVE AND DISASSEMBLE A CENTRIFUGAL CLUTCH

I. Tools and materials

  A. Metric sockets and end wrenches

  B. Impact screwdriver set

  C. Hand tool assortment

  D. Snap ring pliers

  E. T-handle box wrench, 16 mm (some makes and models)

  F. Arbor press or bench vise

  G. Appropriate service manual

  H. Safety glasses

II. Procedure

  A. Remove kickstarter pedal, if necessary

  B. Remove right side crankcase cover screws using impact screwdriver

  C. Remove crankcase side cover

  D. Remove gear change release mechanism

  E. Straighten tab on lock washer that secures 16 mm nut with screwdriver, when so equipped

  F. Remove nut from end of crankshaft, using special T-handle wrench, if necessary

  G. Slide clutch unit off of crankshaft end

  H. Compress clutch release springs by pushing on clutch plates and discs using press or vise

  I. Remove large plate snap ring using snap ring pliers

  J. Remove plates and discs

  K. Slide primary drive gear and clutch center out of clutch unit

  L. Remove centrifugal weights

## JOB SHEET #1

M. Compress clutch drive plate and clutch cover together to release spring tension on the cover to plate attaching bolts using press or vise

N. Remove bolts and separate drive plate and cover

(NOTE: Be sure to retain damper springs.)

# CENTRIFUGAL CLUTCHES
## UNIT I

## JOB SHEET #2--INSPECT AND MEASURE THE PARTS OF A CENTRIFUGAL CLUTCH

I. Tools and materials

A. Micrometer

B. Feeler gauge

C. Flat surface plate

D. Machinist's steel rule or calipers

E. Appropriate service manual

F. Safety glasses

II. Procedure

A. Clean and visually inspect all parts for obvious wear or damage

B. Measure the thickness of the disc lining using the micrometer, and compare with specifications

C. Lay the clutch plate flat, and check plate for warpage at several places around the clutch plate using the feeler gauge and surface plate

D. Place clutch plates on clutch center and check for backlash and compare with specifications

E. Measure the free length of all clutch springs using machinist's rule, and compare with specifications

# CENTRIFUGAL CLUTCHES
## UNIT I

## JOB SHEET #3--REASSEMBLE AND REPLACE A CENTRIFUGAL CLUTCH

I. Tools and materials

  A. Metric sockets and end wrenches

  B. Impact screwdriver set

  C. Hand tool assortment

  D. Snap ring pliers

  E. T-handle box wrench 16 mm (some makes and models)

  F. Arbor press or bench vise

  G. Appropriate service manual

  H. Safety glasses

II. Procedure

  A. Install damper springs and assemble drive plate and clutch cover and compress in press or vise

  B. Install clutch cover bolts and tighten to specifications

  C. Install centrifugal weights

  D. Slide primary drive gear and clutch hub into clutch unit

  E. Install clutch plates and friction discs

  F. Compress clutch release springs with a press or vise and install clutch plate retaining ring

  G. Slide clutch unit onto crankshaft

  H. Install lock washer and 16 mm nut on crankshaft

  I. Tighten nut to specifications and bend lock tab around nut

  J. Install gear change release mechanism

  K. Install crankcase side cover and tighten screws with impact screwdriver

  L. Install kickstarter pedal, if necessary

  M. Start engine and check operation of centrifugal clutch

# CENTRIFUGAL CLUTCHES
# UNIT I

## JOB SHEET #4--ADJUST A CENTRIFUGAL CLUTCH

I. Tools and materials

   A. Metric wrenches

   B. Hand tool assortment

   C. Appropriate service manual

   D. Safety glasses

II. Procedure

   A. Loosen adjusting bolt locknut

   B. If clutch is slipping, turn the adjusting screw clockwise until engine will continue to idle when shifted into gear

   C. If clutch will not disengage, turn the adjusting screw counterclockwise until engine will continue to idle when shifted into gear

## CENTRIFUGAL CLUTCHES
## UNIT I

### TEST

1. Match the terms on the right to the correct definitions.

______a. Heavy steel plate connected to the crankshaft that drives the clutch

______b. Force which tends to move a body away from its center of rotation and increases as the speed of rotation increases

______c. Transfer of power, in proper sequence, from one unit to another

______d. First gear in the power flow driven by the clutch

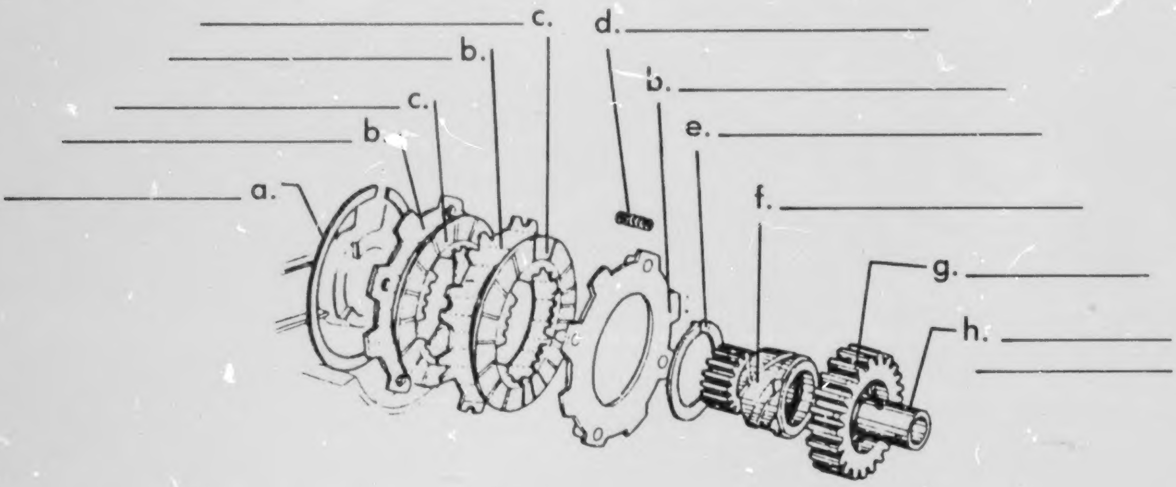
______e. Smooth steel plates that are connected to the drive plate and provide a friction surface for the friction discs

______f. Metal plate that has friction lining bonded to it and is the driven component of the clutch

______g. Weights that generate the necessary force to apply the clutch

1. Power flow
2. Clutch plates
3. Primary drive gear
4. Centrifugal force
5. Friction disc
6. Drive plate
7. Centrifugal weights

2. Identify the parts of the centrifugal clutch.


c.
d.
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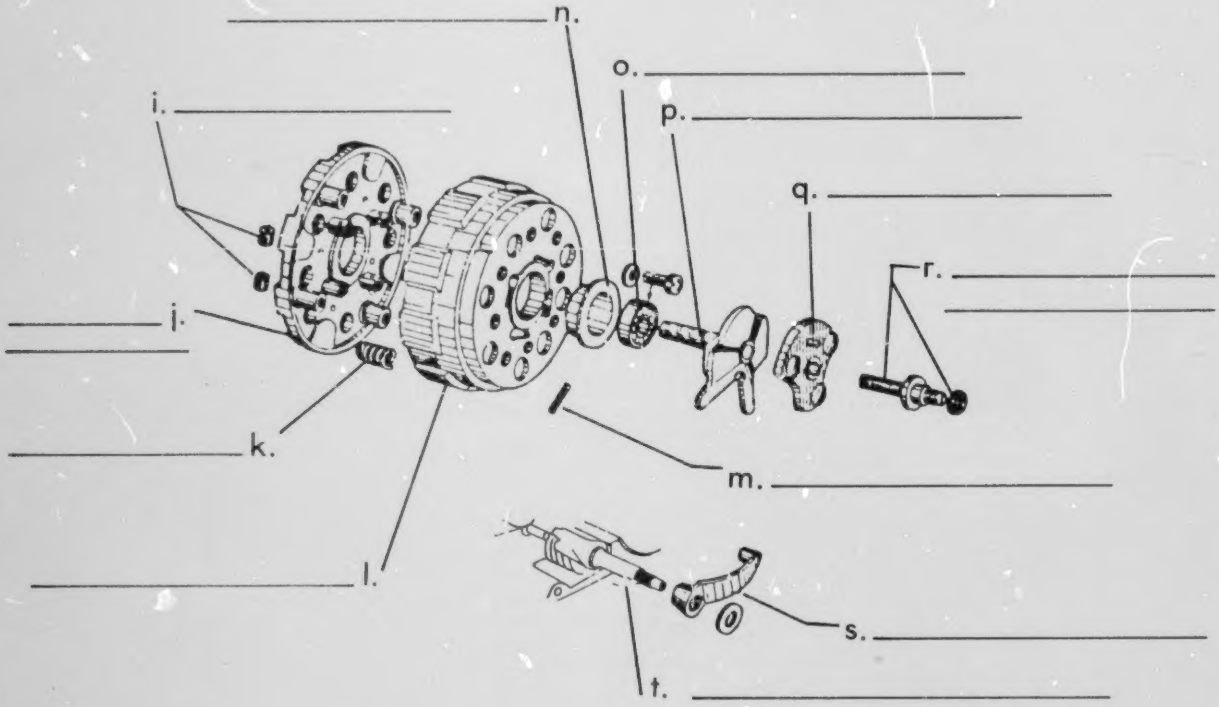
n.
o.
i.
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q.
r.
j.
k.
m.
l.
s.
t.

3. List the types of centrifugal clutch actuating weights.

a.

b.

c.

4. Describe the construction of a centrifugal clutch.

5. Discuss the operation of a centrifugal clutch.

6. Select the causes of specific clutch failures by placing an "X" in the appropriate blanks.

a. Clutch will not engage

______1) Transmission in wrong gear

______2) Worn or broken friction discs

______3) Clutch cable broken

______4) Improper adjustment of gear change mechanism

______5) Centrifugal weights not working properly

______6) Centrifugal weights stuck in outward position

______7) Clutch plate retaining ring broken or missing

______8) Clutch cover return springs broken or missing

b. Clutch will not disengage

______1) Centrifugal weights stuck in inward position

______2) Binding between discs and plates

______3) Engine RPM too low

______4) Weak, broken, or missing clutch return springs

______5) Engine idle RPM too high

______6) Centrifugal weights stuck in outward position

c. Clutch will not disengage while shifting

______1) Faulty release mechanism

______2) Engine RPM too high

______3) Twisted, bent, or broken shift shaft

______4) Improper adjustment of gear change mechanism

______5) Slippage between shift spindle and release lever

7. Demonstrate the ability to:

   a. Remove and disassemble a centrifugal clutch.

   b. Inspect and measure the parts of a centrifugal clutch.

   c. Reassemble and replace a centrifugal clutch.

   d. Adjust a centrifugal clutch.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

## CENTRIFUGAL CLUTCHES
## UNIT I

## ANSWERS TO TEST

1. a. 6
   b. 4
   c. 1
   d. 3
   e. 2
   f. 5
   g. 7

2. a. Clutch plate retaining ring
   b. Clutch plates
   c. Friction discs
   d. Clutch plate return spring
   e. Primary drive gear snap ring
   f. Primary drive gear
   g. Clutch hub
   h. Clutch hub guide or bushing
   i. Centrifugal weights
   j. Drive plate
   k. Clutch cover return spring
   l. Clutch cover
   m. Clutch damper spring
   n. Bearing shell
   o. Clutch release ball bearing
   p. Oil guide and thrust plate
   q. Clutch camplate
   r. Adjusting bolt and locknut
   s. Release lever
   t. Transmission shift shaft

3. a. Roller
   b. Pivot
   c. Steel ball

4. Description should include:
   a. Clutch drive plate, clutch plates, and clutch cover are connected and all rotate together
   b. Friction discs connected to and rotate with clutch hub
   c. Springs hold friction discs and plates apart
   d. Centrifugal weights apply pressure to create friction between plates and discs
   e. Override system
      1) Lever
      2) Camplate bearing
      3) Clutch cover springs
   f. Key factors in construction
      1) Centrifugal weights
         a) Correct size
         b) Correct weight
      2) Drive plate
         a) Alignment
         b) Wear in the area of the centrifugal weights

5. Discussion should include:
   a. Low RPM (1800 RPM and less)
      1) Centrifugal force acting on weights is not enough to overcome return springs that hold clutch plates and friction discs apart
      2) No friction
      3) No transmission of power

b. Medium and high RPM

  1) Centrifugal force causes weights to move outward

  2) Weights move along inclined ramps

    a) Compress return springs

    b) Clutch plates and friction discs come together

    c) Friction causes friction discs to rotate

    d) Power is transmitted to clutch hub and on to primary drive gear

c. Shifting at high RPM

  1) Lever attached to foot pedal rotates camplate

  2) Camplate exerts force on clutch release ball bearing

  3) Bearing pushes clutch cover inward against spring tension

  4) Plates and discs separate to interrupt flow of power even though centrifugal force is still acting upon the weights

  5) Shifting can be accomplished smoothly with no power being transmitted

6. a. 2, 4, 5, 7, 8

   b. 2, 4, 5, 6

   c. 1, 3, 4, 5

7. Performance skills evaluated to the satisfaction of the instructor

# MULTIPLATE CLUTCHES
## UNIT II

## UNIT OBJECTIVE

After completion of this unit, the student should be able to identify the parts of the multiplate clutch, match the parts to the descriptions, arrange the steps of operation, and select causes of clutch failure. The student should also be able to remove, disassemble, service, install, and adjust a multiplate clutch. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with multiplate clutches to the correct definitions.
2. Identify the parts of the multiplate clutch.
3. Match the parts of the multiplate clutch to the correct descriptions.
4. Arrange in order the steps in the operation of a multiplate clutch.
5. Select the causes of specific clutch failures.
6. Demonstrate the ability to:
    a. Remove and disassemble a multiplate clutch.
    b. Inspect and measure clutch parts for wear and damage.
    c. Reassemble and install a multiplate clutch.
    d. Adjust a clutch to specifications.

# MULTIPLATE CLUTCHES
## UNIT II

## SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide student with objective sheet.
- B. Provide student with information and job sheets.
- C. Make transparencies.
- D. Discuss unit and specific objectives.
- E. Discuss information sheet.
- F. Demonstrate and discuss the procedures outlined in the job sheets.
- G. Give test.

II. Student:

- A. Read objective sheet.
- B. Study information sheet.
- C. Complete job sheets.
- D. Complete activities assigned by instructor.
- E. Take test.

## INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheet
- C. Transparency masters
    1. TM 1--Parts of a Multiplate Clutch
    2. TM 2--Clutch Release Mechanisms

D. Job sheets

1. Job Sheet #1--Remove and Disassemble a Multiplate Clutch
2. Job Sheet #2--Inspect and Measure Clutch Parts for Wear and Damage
3. Job Sheet #3--Reassemble and Install a Multiplate Clutch
4. Job Sheet #4--Adjust a Clutch to Specifications

E. Test

F. Answers to test

II. References:

A. *Honda 750 Service Manual*. Honda Motor Co., Ltd.

B. *Honda 450 Service Manual.* Honda Motor Co., Ltd., 1971.

C. *Motorcycle Systems Training Manual-Motorcycle Power Train.* Kawasaki Motors Corp., 1973.

D. *Suzuki 500 Service Manual.* Suzuki Motor Co., Ltd., 1969.

E. *Chilton's Triumph Service Manual.* Radnor, Pennsylvania: Chilton Book Co., 1973.

F. *Suzuki 350 Parts Catalogue.* Suzuki Motor Co., Ltd., 1972.

G. Ritch, Ocee. *Chilton's Motorcycle Troubleshooting Guide.* Radnor, Pennsylvania: Chilton Book Co., 1966.

III. Additional materials:

A. BSA Service Training Charts

B. Suzuki Service Training Charts

# MULTIPLATE CLUTCHES
## UNIT II

## INFORMATION SHEET

I. Terms and definitions

   A. Primary drive gear--Gear on crankshaft that drives gear on clutch housing

   B. Primary driven gear--Gear on clutch housing that is driven by the primary drive gear

   C. Clutch push crown--Device that transmits pushing motion of push screw to rotating clutch pressure plate

   D. Clutch release push screw--Device used to convert pulling motion of clutch cable to pushing motion that operates the clutch by the action of coarse threads

   E. Push rod--Transmits pushing motion of push screw to push crown

   F. Clutch release camplate--Device used to convert pulling motion of clutch cable to pushing motion that operates the clutch by means of ball bearings sandwiched between two camplates

II. Parts of multiplate clutch (Tranparency 1)

   A. Primary drive gear

   B. Primary driven gear and clutch housing

   C. Clutch hub

   D. Clutch hub snap ring

   (NOTE: Many clutches use a locknut in place of the snap ring.)

   E. Clutch plates

   F. Friction discs

   G. Clutch pressure plate

   H. Pressure springs

   I. Pressure spring screws and washers

   J. Clutch lever

## INFORMATION SHEET

K. Clutch cable

L. Outer clutch release push screw

M. Inner clutch release push screw

N. Clutch lever return spring

O. Push rod ball bearing

P. Push rod

Q. Push crown

III. Descriptions of multiplate clutch parts

A. Primary drive gear

1. Splined to engine crankshaft

2. Meshes with primary driven gear on clutch housing

B. Clutch housing

1. Rotates on transmission input shaft, but is not connected to it

2. Slotted to accept tabs on outer rim of friction discs

C. Friction discs

1. Friction material bonded to steel discs having tabs on outer rim

2. Stacked alternately with clutch plates to form "clutch pack"

D. Clutch plates

1. Smooth steel plates with teeth on inner rim

2. Mesh with slots on outer rim of clutch hub

E. Clutch hub

1. Splined or keyed to transmission input shaft

2. Mounting base for clutch pressure plate

## INFORMATION SHEET

F. Clutch pressure plate

  1. Compresses "clutch pack" to create friction between discs

  2. Rotates with clutch hub

G. Pressure springs--Provide pressure for clutch pressure plate

H. Mounting bolts--Secure clutch pressure plate to clutch hub

I. Push crown

  1. Contacts clutch pressure plate

  2. Transmits force of push rod to clutch pressure plate

J. Push rod

  1. Transmits force from push screw through center of clutch to push crown

  2. Incorporates small steel ball in middle or one end to eliminate friction caused by rotating pressure plate

K. Clutch release mechanism (Transparency 2)

  1. Converts pulling motion from clutch cable to pushing motion to operate clutch pressure plate

  2. Push screw or ball and camplate designs

IV. Operation of multiplate clutch

A. Operator pulls hand lever

  1. Motion is transmitted by clutch cable to push screw

  2. Push screw forces push rod through center of clutch to activate push crown

  3. Push crown pushes on clutch pressure plate causing it to move outward

  4. Clutch pressure plate moves outward, compresses pressure springs, and releases pressure on "clutch pack"

  5. Clutch plates and friction discs separate due to release of pressure

## INFORMATION SHEET

6. Clutch hub no longer rotates with clutch housing without friction between plates and discs

7. No power is transmitted to transmission, and smooth shifting of gears is possible

B. Operator releases hand lever

1. Clutch cable return spring at push screw returns push screw to original position and pulls clutch cable and hand lever back to "at rest" position

2. Push screw releases pressure on push rod and push crown

3. Pressure springs force clutch pressure plate inward

4. Clutch pressure plate moving inward compresses friction discs and clutch plates

5. Compressed "clutch pack" creates friction causing clutch hub and clutch housing to rotate as an integral unit

6. Power is transmitted from primary drive gear to primary driven gear on clutch housing, to the compressed clutch pack, and to clutch hub which is connected to transmission input shaft

V. Causes of clutch failures

A. Clutch will not engage or slips

1. Worn friction discs or clutch plates

2. Not enough free play in clutch linkage

3. Weak or broken pressure springs

4. Seized cable, push rod, or linkage

5. Bent or damaged push rod

B. Clutch will not disengage

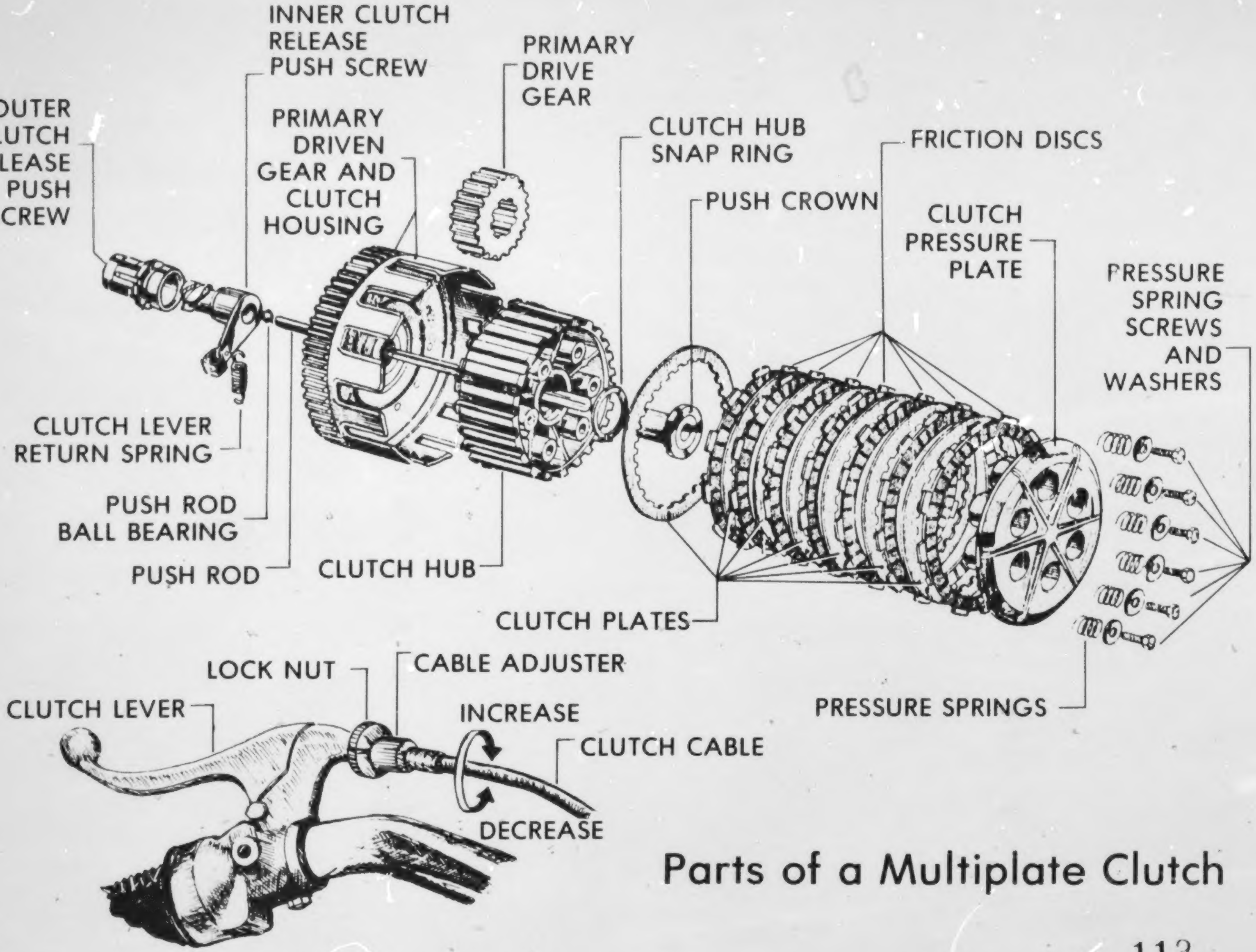
1. Too much free play in clutch linkage

2. Worn clutch-release mechanism

3. Stretched or misadjusted clutch cable

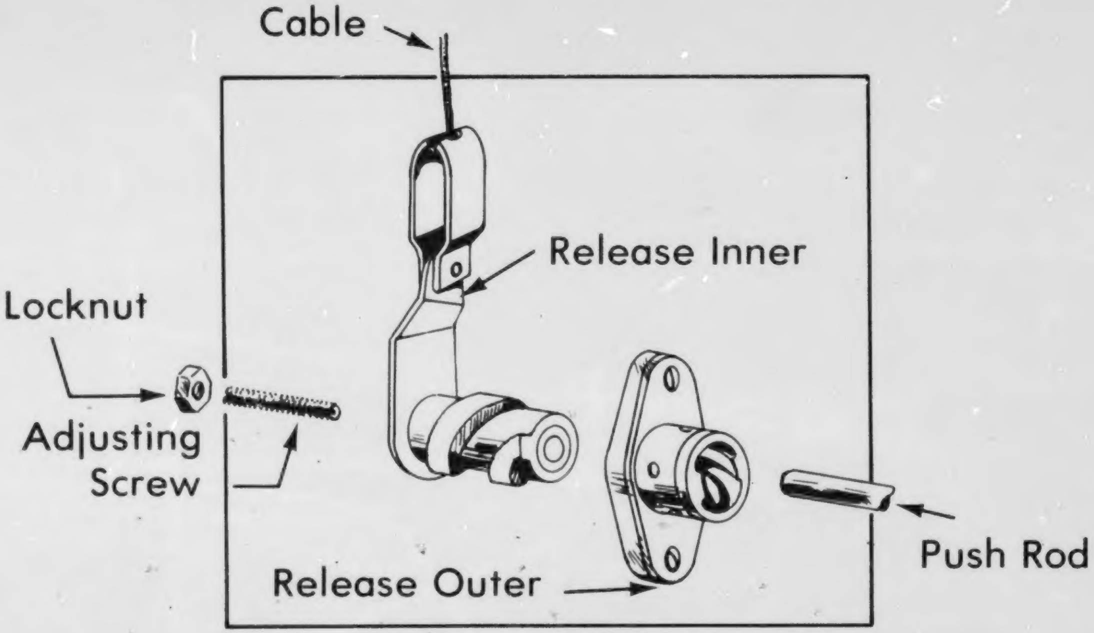
4. Binding clutch plates and friction discs

5. Warped or distorted clutch plates or friction discs

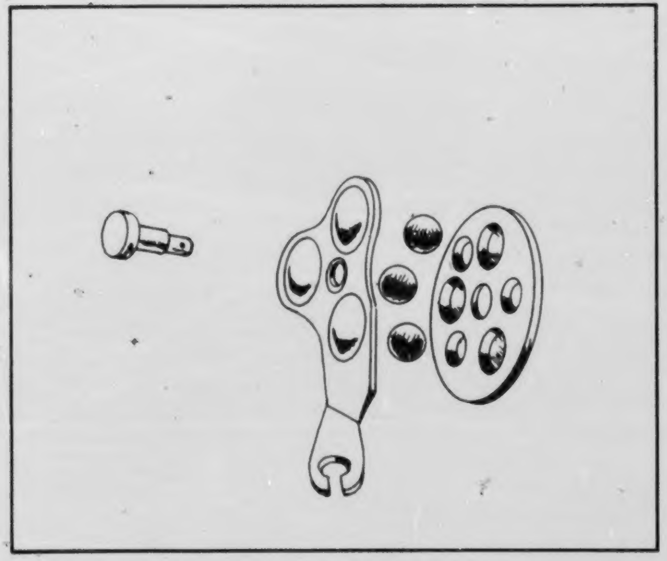

INNER CLUTCH RELEASE PUSH SCREW
PRIMARY DRIVE GEAR
OUTER CLUTCH RELEASE PUSH SCREW
PRIMARY DRIVEN GEAR AND CLUTCH HOUSING
CLUTCH HUB SNAP RING
FRICTION DISCS
PUSH CROWN
CLUTCH PRESSURE PLATE
PRESSURE SPRING SCREWS AND WASHERS
CLUTCH LEVER RETURN SPRING
PUSH ROD BALL BEARING
PUSH ROD
CLUTCH HUB
CLUTCH PLATES
LOCK NUT
CABLE ADJUSTER
CLUTCH LEVER
INCREASE
CLUTCH CABLE
DECREASE
PRESSURE SPRINGS

Parts of a Multiplate Clutch

# Clutch Release Mechanisms


Cable
Release Inner
Locknut
Adjusting Screw
Push Rod
Release Outer

PUSH SCREW



BALL AND CAMPLATE

# MULTIPLATE CLUTCHES
## UNIT II

## JOB SHEET #1--REMOVE AND DISASSEMBLE A MULTIPLATE CLUTCH

I. Tools and materials

- A. Metric socket wrench set
- B. Metric end wrench set
- C. Hand tool assortment
- D. Appropriate service manual
- E. Drain pan
- F. Safety glasses

II. Procedure

(NOTE: Follow the service manual procedures exactly for the type of vehicle you are working on.)

- A. Drain engine oil
- B. Remove kickstart lever
- C. Remove engine crankcase side cover
- D. Remove the pressure plate mounting screws and pressure springs
- E. Remove pressure plate and push crown

  (NOTE: Depending on the brand of motorcycle, when the push crown is removed, be alert for a small steel ball in the push rod linkage. This ball is a bearing and may be located at either end or in the middle of the push rod.)

- F. Remove the clutch hub retaining snap ring or large nut
- G. Remove the clutch assembly from the transmission input shaft
- H. Remove the clutch hub, discs, and plates from the clutch housing
- I. Separate discs, plates, and clutch hub
- J. Remove clutch release push screw from crankcase side cover

# MULTIPLATE CLUTCHES
# UNIT II

## JOB SHEET #2--INSPECT AND MEASURE CLUTCH PARTS FOR WEAR AND DAMAGE

I. Tools and materials

A. Multiplate clutch unit (complete)

B. 0-1" micrometer or vernier caliper

C. Feeler gauge pack

D. Surface block

E. Straight edge

F. Appropriate service manual

G. Safety glasses

II. Procedure

A. Inspect friction discs for excessive wear and overheating

B. Measure friction disc lining thickness with micrometer or caliper and compare with service manual specifications (Figure 1)

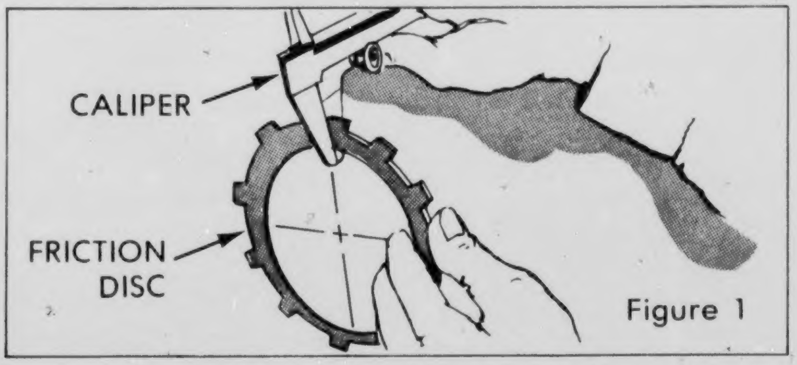


Figure 1

C. Inspect the clutch housing fingers where the friction disc tabs contact for excessive wear

D. Place friction discs in clutch housing, measure clearance (backlash) between clutch housing fingers and friction disc tabs, and compare with service manual specifications

E. Inspect clutch plates for excessive wear and overheating

## JOB SHEET #2

F. Place clutch plates on flat surface plate one at a time, insert feeler gauge between clutch plate and surface plate to check for warpage, and compare with service manual warpage allowances (Figure 2)

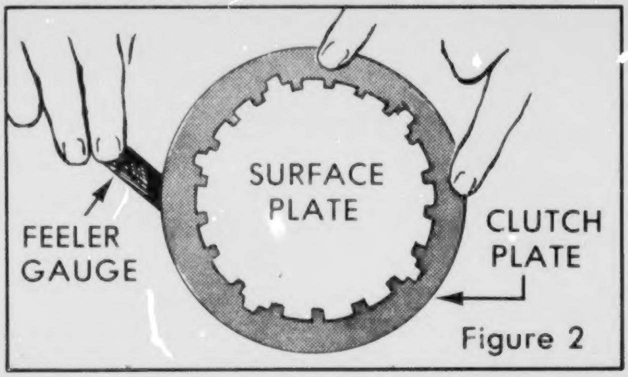

SURFACE PLATE
FEELER GAUGE
CLUTCH PLATE

Figure 2

G. Measure free length of pressure springs with vernier caliper and compare with service manual specifications (Figure 3)

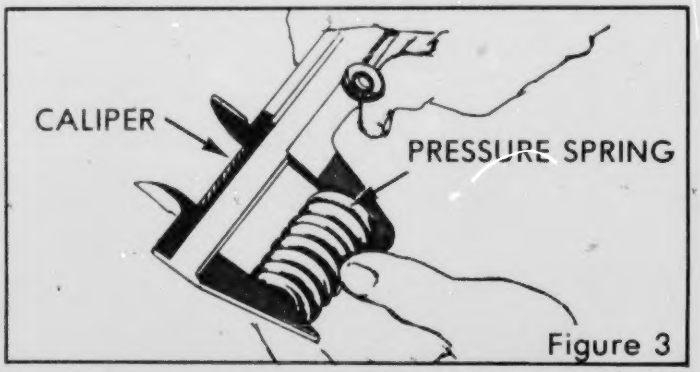

CALIPER
PRESSURE SPRING

Figure 3

H. Inspect clutch release push screw for damage and lack of lubrication

# MULTIPLATE CLUTCHES
## UNIT II

## JOB SHEET #3--REASSEMBLE AND INSTALL A MULTIPLATE CLUTCH

I. Tools and materials

- A. Metric socket wrench set
- B. Metric end wrench set
- C. Hand tool assortment
- D. Appropriate service manual
- E. Appropriate engine oil
- F. Safety glasses

II. Procedure

- A. Apply grease to clutch release push screw and install in the crankcase cover
- B. Connect clutch cable to clutch release push screw
- C. Coat the friction discs with fresh engine oil and assemble the discs and clutch plates onto the clutch hub
- D. Install the plate, disc, and hub assembly into the clutch housing
- E. Install clutch assembly on the transmission input shaft and secure with clutch hub snap ring or large nut and lock tab

  (NOTE: Tighten large nut according to service manual specifications.)
- F. Install push crown into end of transmission input shaft
- G. Install pressure plate onto clutch hub and secure with mounting screws and pressure springs
- H. Install engine crankcase side cover
- I. Install kickstart lever
- K. Refill engine with oil according to service manual specifications

## MULTIPLATE CLUTCHES
## UNIT II

### JOB SHEET #4 ADJUST A CLUTCH TO SPECIFICATIONS

I. Tools and materials

   A. Metric end wrench set

   B. Hand tool assortment

   C. Machinist's steel rule

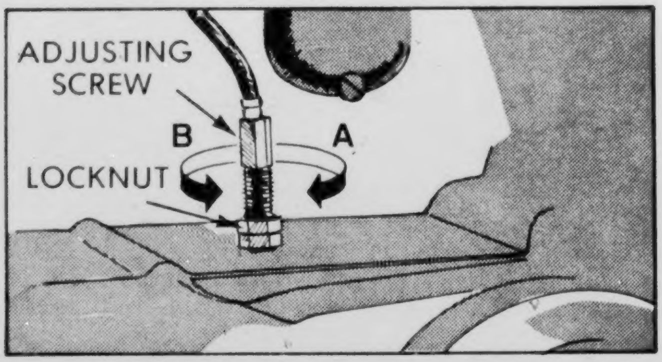
   D. Appropriate service manual

   E. Safety glasses

II. Procedure

   A. Loosen clutch cable adjuster locknuts at each end of the cable, the hand lever end and the crankcase side cover end

   B. Rotate clutch cable adjuster clockwise as far as possible to give maximum cable slack (Figure 1)



A. This direction increases free play

B. This direction decreases free play

Figure 1

   C. Loosen clutch adjusting screw locknut on crankcase side cover (Figure 2)

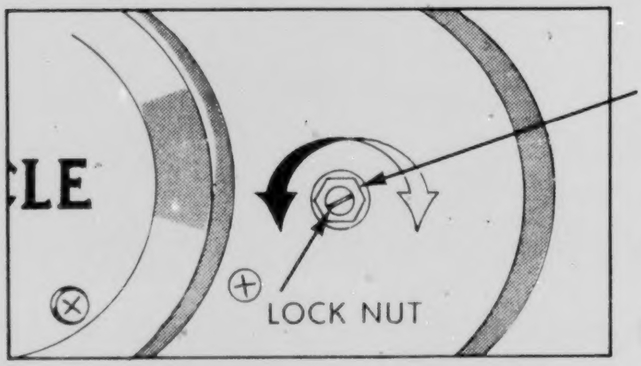


Figure 2

JOB SHEET #4

D. Rotate adjusting screw clockwise until a slight resistance is encountered (Figure 2)

(NOTE: This clockwise direction of the adjusting screw decreases the free play.)

E. Rotate adjusting screw 1/4 to 1/2 turn counterclockwise and secure with locknut (Figure 2)

(NOTE: This counterclockwise direction of the adjusting screw increases the free play.)

F. Rotate clutch cable adjusters at the crankcase side cover counterclockwise until the proper cable free play is obtained

(NOTE: Make all cable adjustments at crankcase side cover if possible and at hand lever end as a last resort. See Figure 3.)

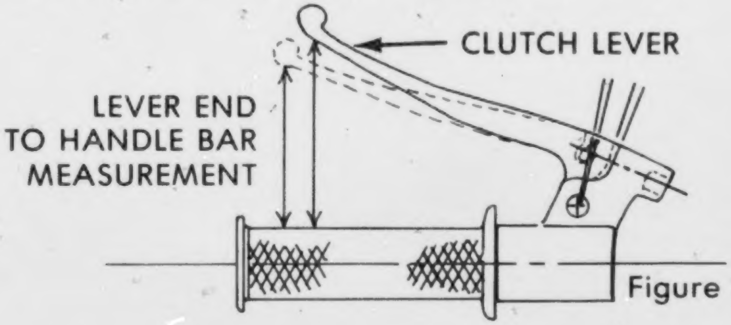


Figure 3

G. Secure the locknuts at the hand lever end and crankcase side cover end

H. Test adjustment by pulling in the clutch hand lever and shifting the transmission into first gear

(NOTE: The engine should not stall or try to creep forward.)

## MULTIPLATE CLUTCHES
## UNIT II

## TEST

1. Match the terms on the right to the correct definitions.

_____a. Transmits pushing motion of push screw to push crown

_____b. Gear on crankshaft that drives gear on clutch housing

_____c. Device that transmits pushing motion of push screw to rotating clutch pressure plate

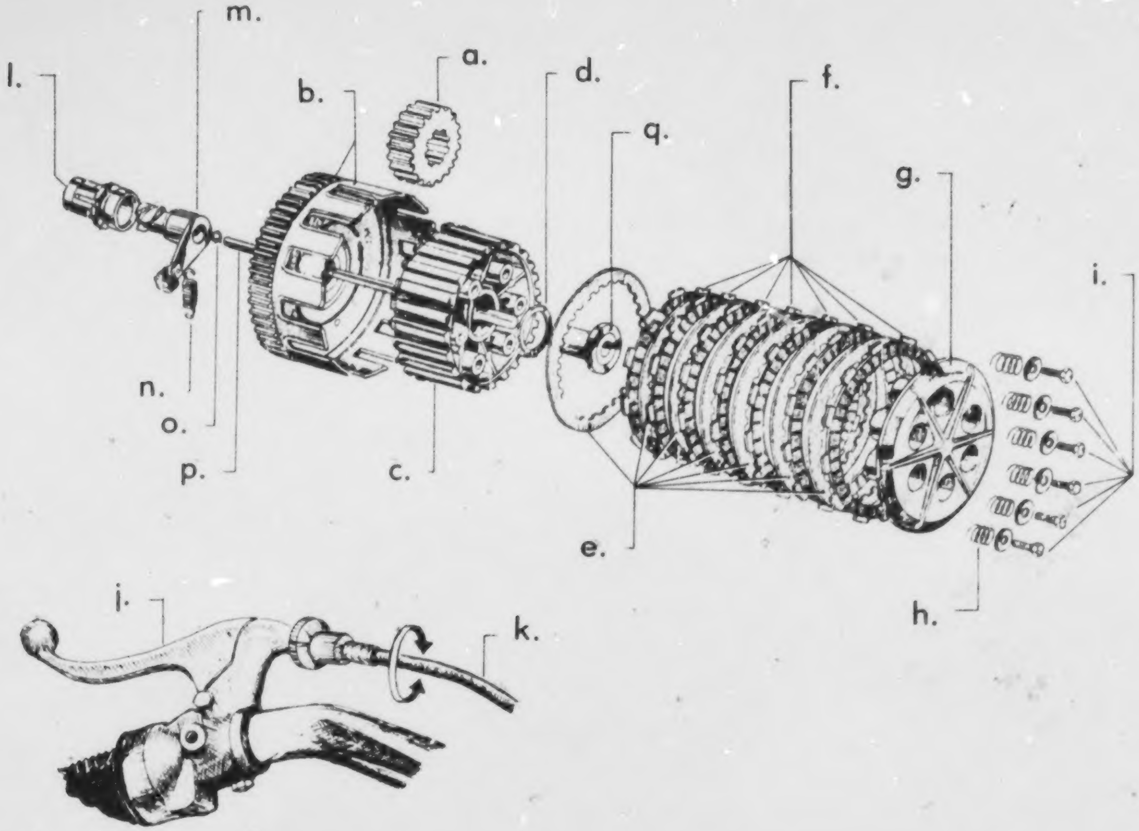
_____d. Gear on clutch housing that is driven by the primary drive gear

_____e. Device used to convert pulling motion of clutch cable to pushing motion that operates the clutch by means of ball bearings sandwiched between two camplates

_____f. Device used to convert pulling motion of clutch cable to pushing motion that operates the clutch by the action of coarse threads

1. Clutch release camplate
2. Primary driven gear
3. Clutch release push screw
4. Push rod
5. Clutch push crown
6. Primary drive gear

2. Identify the parts of the multiplate clutch.


m.
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n.

o.

p.

q.

3. Match the parts of the multiplate clutch on the right to the correct descriptions.

______a. Splined to engine crankshaft

______b. Slotted to accept tabs on outer rim of friction discs

______c. Compresses "clutch pack" to create friction between discs

______d. Transmits force from push screw through center of clutch to push crown

______e. Transmits force of push rod to clutch pressure plate

______f. Smooth steel plates with teeth on inner rim

______g. Provide pressure for clutch pressure plate

______h. Stacked alternately with clutch plates to form "clutch pack"

______i. Converts pulling motion from clutch cable to pushing motion to operate clutch pressure plate

______j. Mounting base for clutch pressure plate

______k. Secure clutch pressure plate to clutch hub

1. Clutch pressure plate
2. Pressure springs
3. Clutch hub
4. Primary drive gear
5. Push crown
6. Friction discs
7. Clutch housing
8. Clutch release mechanism
9. Clutch plates
10. Mounting bolts
11. Push rod

4. Arrange in order the following steps under both sections by placing the correct sequence letter in the appropriate blank.

a. Operator pulls hand lever

______1) No power is transmitted to transmission, and smooth shifting of gears is possible

______2) Clutch pressure plate moves outward, compresses pressure springs, and releases pressure on "clutch pack"

______3) Clutch hub no longer rotates with clutch housing without friction between plates and discs

______4) Motion is transmitted by clutch cable to push screw

______5) Push crown pushes on clutch pressure plate causing it to move outward

_____6) Clutch plates and friction discs separate due to release of pressure

_____7) Push screw forces push rod through center of clutch to activate push crown

b. Operator releases hand lever

_____1) Compressed "clutch pack" creates friction causing clutch hub and clutch housing to rotate as an integral unit

_____2) Push screw releases pressure on push rod and push crown

_____3) Power is transmitted from primary drive gear to primary driven gear on clutch housing, to the compressed clutch pack, and to clutch hub which is connected to transmission input shaft

_____4) Pressure springs force clutch pressure plate inward

_____5) Clutch cable return spring at push screw returns push screw to original position and pulls clutch cable and hand lever back to "at rest" position

_____6) Clutch pressure plate moving inward compresses friction discs and clutch plates

5. Select the causes of specific clutch failures by placing an "X" in the appropriate blanks.

a. Clutch will not engage or slips

_____1) Worn friction discs or clutch plates

_____2) Broken clutch cable

_____3) Incorrect arrangement of clutch plates and friction discs

_____4) Seized cable, push rod, or linkage

_____5) Too much free play in clutch linkage

_____6) Weak or broken pressure springs

_____7) Not enough free play in clutch linkage

b. Clutch will not disengage

_____1) Not enough free play in clutch linkage

_____2) Worn clutch release mechanism

_____3) Missing friction disc

_____4) Warped or distorted clutch plates or friction discs

_____5) Stretched or misadjusted clutch cable

_____6) Too much free play in clutch linkage

_____7) Leaking hydraulic lines

_____8) Binding clutch plates and friction discs

6. Demonstrate the ability to:

   a. Remove and disassemble a multiplate clutch.

   b. Inspect and measure clutch parts for wear and damage.

   c. Reassemble and install a multiplate clutch.

   d. Adjust a clutch to specifications.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

## MULTIPLATE CLUTCHES
## UNIT II

### ANSWERS TO TEST

1. a. 4
   b. 6
   c. 5
   d. 2
   e. 1
   f. 3
2. a. Primary drive gear
   b. Primary driven gear and clutch housing
   c. Clutch hub
   d. Clutch hub snap ring
   e. Clutch plates
   f. Friction discs
   g. Clutch pressure plate
   h. Pressure springs
   i. Pressure spring screws and washers
   j. Clutch lever
   k. Clutch cable
   l. Outer clutch release push screw
   m. Inner clutch release push screw
   n. Clutch lever return spring
   o. Push rod ball bearing
   p. Push rod
   q. Push crown

3. a. 4
   b. 7
   c. 1
   d. 11
   e. 5
   f. 9
   g. 2
   h. 6
   i. 8
   j. 3
   k. 10

4. a. Operator pulls hand lever
      1) g
      2) d
      3) f
      4) a
      5) c
      6) e
      7) b
   b. Operator releases hand lever
      1) e
      2) b
      3) f
      4) c
      5) a
      6) d

5. a. 1, 4, 6, 7
   b. 2, 4, 5, 6, 8

6. Performance skills evaluated to the satisfaction of the instructor

# AUTOMOTIVE SINGLE PLATE CLUTCHES
## UNIT III

## UNIT OBJECTIVE

After completion of this unit, the student should be able to define the terms associated with automotive single plate clutches and identify the parts. The student should also be able to describe the construction, arrange the steps of operation for a single plate clutch, list causes of clutch malfunctions, and demonstrate the ability to remove, disassemble, inspect, and reinstall a single plate clutch. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define terms associated with automotive single plate clutches.
2. Identify the parts of an automotive single plate clutch.
3. Describe the construction of an automotive single plate clutch.
4. Arrange in order the steps of operation for an automotive single plate clutch.
5. Select the causes of specific clutch malfunctions.
6. Demonstrate the ability to remove, disassemble, inspect, and reinstall a single plate clutch.

# AUTOMOTIVE SINGLE PLATE CLUTCHES
## UNIT III

## SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss the procedure outlined in the job sheet.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheet.

   D. Complete activities assigned by instructor.

   E. Take test.

## INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Automotive Single Plate Clutch Parts

      2. TM 2--Automotive Single Plate Clutch Construction and Operation

D. Job Sheet #1--Remove, Disassemble, Inspect, and Reinstall a Single Plate Clutch

E. Test

F. Answers to test

II. References:

A. *Chilton's BMW Motorcycle Repair and Tune-Up Guide*. Radnor, Pennsylvania: Chilton Book Co., 1973.

B. *Motorcycle Service Manual.* Vol. 1. 3rd ed. Kansas City, Missouri: Technical Publications Division/Intertec Publishing Corp., 1972.

C. Ritch, Ocee. *Chilton's Motorcycle Troubleshooting Guide.* Radnor, Pennsylvania: Chilton Book Co., 1966.

D. *Motorcycle Service Manual.* Vol. 2. 3rd ed. Kansas City, Missouri: Technical Publications Division/Intertec Publishing Corp., 1972.

# AUTOMOTIVE SINGLE PLATE CLUTCHES
## UNIT III

## INFORMATION SHEET

I. Terms and definitions

  A. Diaphragm spring--Circular, dish-shaped, spring steel plate with fingers formed on the inner radius to facilitate flexing

  B. Pressure ring--Steel ring attached to the outer face of the flywheel that forms the outer friction surface

  C. Radial runout--Side to side movement of a circular object as it rotates on its axis

II. Parts of an automotive single plate clutch (Transparency 1)

  A. Pressure ring

  B. Friction disc

  C. Pressure plate

  D. Diaphragm spring

III. Construction of an automotive single plate clutch (Transparency 2)

  A. Flywheel is connected to engine crankshaft

  B. Clutch components assembled within recessed face of flywheel

    1. Diaphragm spring next to flywheel face

    2. Pressure plate between diaphragm spring and friction disc forms inner friction surface

    3. Pressure ring bolts to outer face of flywheel to form outer friction surface

  C. Clutch release push rod operates through center of transmission input shaft

  D. Dry type clutch

IV. Operation of an automotive single plate clutch (Transparency 2)

  A. Operator compresses clutch hand lever

    1. Motion is transmitted through clutch cable to release lever

## INFORMATION SHEET

2. Release lever moves push rod through transmission input shaft to act on pressure plate

3. Pressure plate causes diaphragm spring to flex, releasing pressure on friction disc

4. Friction disc moves away from pressure ring

5. No power is transmitted to transmission because

    a. No friction between friction disc and pressure plate

    b. No friction between friction disc and pressure ring

B. Operator releases clutch hand lever

1. Pressure on push rod is released

2. Diaphragm spring returns to original shape

    a. Moves push rod, release lever, and clutch cable back to the "at rest" position

    b. Compresses friction disc between pressure ring and pressure plate

3. Power is transmitted to transmission because

    a. Friction is created between pressure plate and friction disc

    b. Friction is created between pressure ring and friction disc

V. Clutch malfunctions and causes

A. Clutch will not engage or slips

1. Insufficient linkage free play

2. Worn friction disc

3. Weak or broken diaphragm spring

4. Oil on friction disc lining

5. Loose pressure plate screws

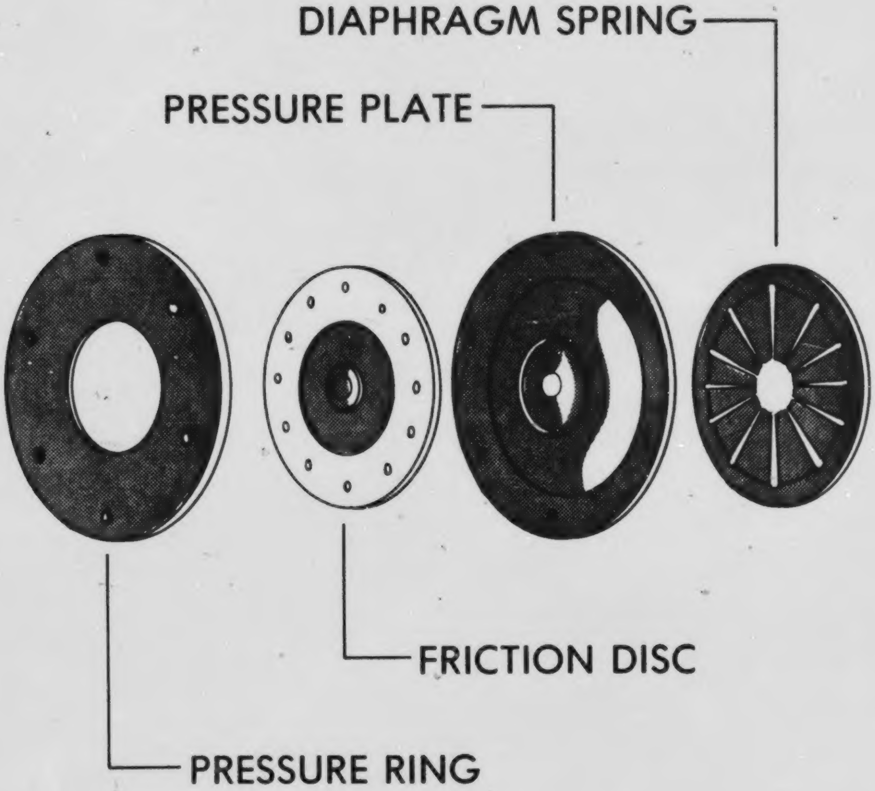
6. Worn pressure ring

## INFORMATION SHEET

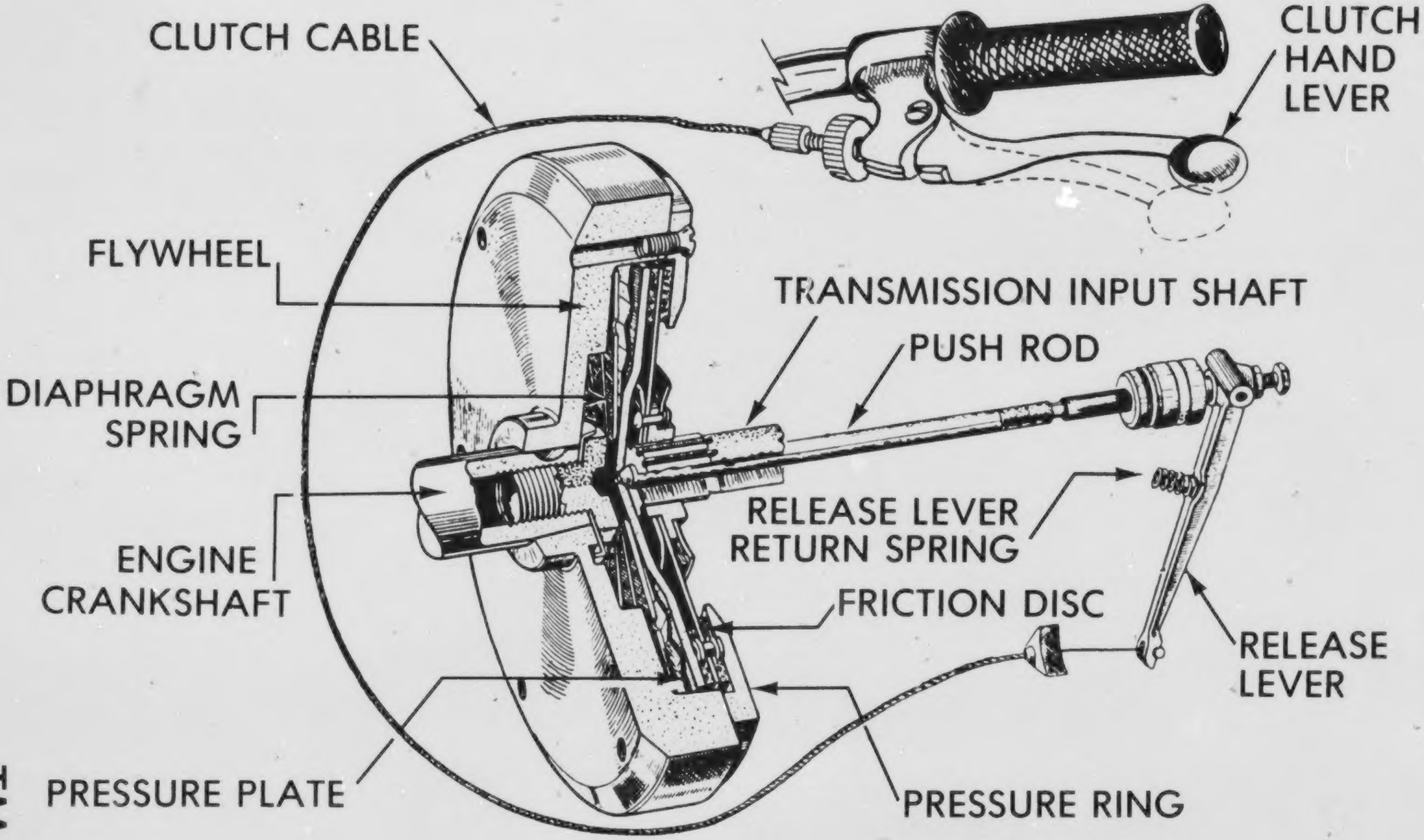
B. Clutch will not disengage or drags

1. Too much linkage free play
2. Distorted or warped friction disc
3. Contaminated friction disc lining

# Automotive Single Plate Clutch Parts


DIAPHRAGM SPRING
PRESSURE PLATE
FRICTION DISC
PRESSURE RING

# Automotive Type Single Plate Clutch Construction and Operation


CLUTCH CABLE
CLUTCH HAND LEVER
FLYWHEEL
TRANSMISSION INPUT SHAFT
PUSH ROD
DIAPHRAGM SPRING
ENGINE CRANKSHAFT
RELEASE LEVER RETURN SPRING
FRICTION DISC
RELEASE LEVER
PRESSURE PLATE
PRESSURE RING

# AUTOMOTIVE SINGLE PLATE CLUTCHES
## UNIT III

## JOB SHEET #1--REMOVE, DISASSEMBLE, INSPECT, AND REINSTALL A SINGLE PLATE CLUTCH

I. Tools and materials

   A. Metric socket set

   B. Metric end wrench

   C. Hand tool assortment

   D. Dial indicator

   E. Appropriate service manual

   F. Set of centers

   G. Surplus transmission input shaft or universal clutch alignment tool

   H. Safety glasses

II. Procedure

(NOTE: Some makes of motorcycles require removal of the engine or transmission for access to the clutch. Consult appropriate service manual for instructions.)

   A. Remove alternately every other retaining bolt from pressure ring

   (NOTE: Remove slowly and evenly until all spring pressure is released to prevent damage to clutch.)

   B. Remove the pressure ring, friction disc, and pressure plate with diaphragm spring

   C. Inspect clutch components for heat warpage, oil saturation, or excessive wear

## JOB SHEET #1

D. Mount friction disc on centers and measure radial runout with dial indicator (Figure 1)

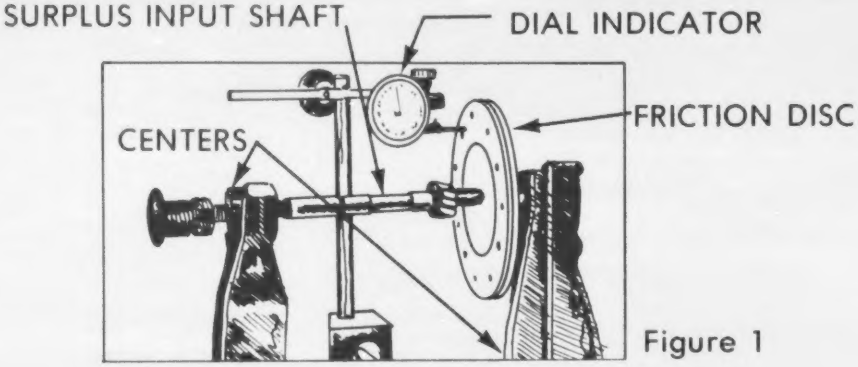

SURPLUS INPUT SHAFT
DIAL INDICATOR
FRICTION DISC
CENTERS

Figure 1

E. Install pressure plate with diaphragm, friction disc, and pressure ring

(NOTE: Use surplus transmission input shaft or universal clutch alignment tool to align friction disc

F. Install retaining bolts

(NOTE: To prevent damage to clutch, tighten slowly and evenly until the spring is compressed.)

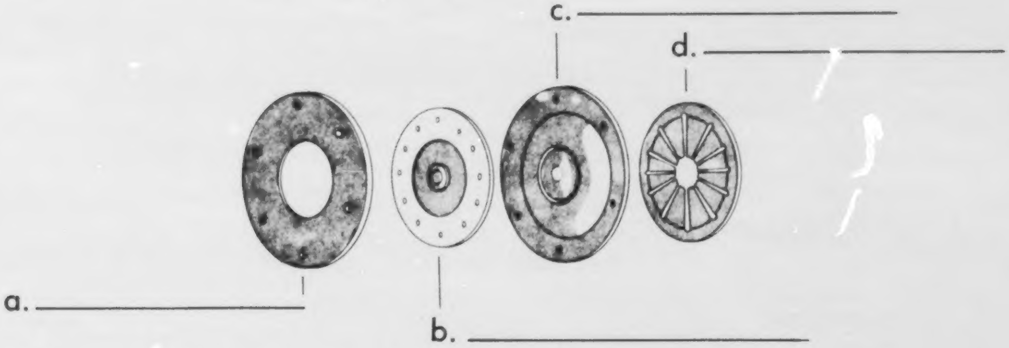
G. Adjust clutch linkage according to specifications

# AUTOMOTIVE SINGLE PLATE CLUTCHES
## UNIT III

## TEST

1. Define the terms associated with automotive single plate clutches.
   a. Diaphragm spring--
   b. Pressure ring--
   c. Radial runout--

2. Identify the parts of an automotive single plate clutch.



3. Describe the construction of an automotive single plate clutch.

4. Arrange in order the following steps under each section of operation for an automotive single plate clutch by placing the correct sequence letter in the appropriate blank.

   a. Operator compresses clutch hand lever

      ______1) Pressure plate causes diaphragm spring to flex, releasing pressure on friction disc

      ______2) No power is transmitted to transmission because

         a) No friction between friction disc and pressure plate

         b) No friction between friction disc and pressure ring

      ______3) Motion is transmitted through clutch cable to release lever

      ______4) Release lever moves push rod through transmission input shaft to act on pressure plate

      ______5) Friction disc moves away from pressure ring

   b. Operator releases clutch hand lever

      ______1) Power is transmitted to transmission because

         a) Friction is created between pressure plate and friction disc

         b) Friction is created between pressure ring and friction disc

      ______2) Pressure on push rod is released

      ______3) Diaphragm spring returns to original shape

         a) Moves push rod, release lever, and clutch cable back to the "at rest" position

         b) Compresses friction disc between pressure ring and pressure plate

5. Select the possible causes of specific clutch malfunctions by placing an "X" in the appropriate blanks.

   a. Clutch will not engage or slips

      ______1) Broken clutch cable

      ______2) Insufficient linkage free play

      ______3) Worn pressure ring

______4) Incorrect tire pressure

______5) Weak or broken diaphragm spring

______6) Oil on friction disc lining

b. Clutch will not disengage or drags

______1) Distorted or warped friction disc

______2) Loose pressure plate screws

______3) Too much linkage free play

______4) Insufficient linkage free play

______5) Contaminated friction disc lining

6. Demonstrate the ability to remove, disassemble, inspect, and reinstall a single plate clutch.

(NOTE: If this activity has not been accomplished prior to the test, ask your instructor when it should be completed.)

# AUTOMOTIVE SINGLE PLATE CLUTCHES
## UNIT III

## ANSWERS TO TEST

1. a. Diaphragm spring--Circular, dish-shaped, spring steel plate with fingers formed on the inner radius to facilitate flexing

   b. Pressure ring--Steel ring attached to the outer face of the flywheel that forms the outer friction surface

   c. Radial runout--Side to side movement of a circular object as it rotates on its axis

2. a. Pressure ring

   b. Friction disc

   c. Pressure plate

   d. Diaphragm spring

3. Description should include:

   a. Flywheel is connected to engine crankshaft

   b. Clutch components assembled within recessed face of flywheel

      1) Diaphragm spring next to flywheel face

      2) Pressure plate between diaphragm spring and friction disc forms inner friction surface

      3) Pressure ring bolts to outer face of flywheel to form outer friction surface

   c. Clutch release push rod operates through center of transmission input shaft

   d. Dry type clutch

4. a. Operator compresses clutch hand lever

      1) c

      2) e

      3) a

      4) b

      5) d

b. Operator releases clutch händ lever

  1) c

  2) a

  3) b

5. a. 2, 3, 5, 6

   b. 1, 3, 5

6. Performance skill evaluated to the satisfaction of the instructor

# CONSTANT MESH DESIGN
## UNIT I

## UNIT OBJECTIVE

After completion of this unit, the student should be able to identify the parts of the constant mesh transmission and describe the system for gear designation. The student should also be able to select the types of gears, select the types of shifter mechanisms, and list the important points in construction design. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with constant mesh design to the correct definitions.
2. Identify the parts of the constant mesh transmission.
3. Describe the system for gear designation.
4. Select the types of transmission gears.
5. Select the types of transmission shifter mechanisms.
6. List important points in transmission construction design.
7. List the major parts of a drum shifter mechanism.
8. Select the major parts of a camplate and shift quadrant shifter mechanism.
9. List the major parts of the ball lock shifter mechanism.

## CONSTANT MESH DESIGN
## UNIT I

### SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information sheet.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheet.

  F. Obtain an assortment of transmission gears, shafts, and shifter mechanisms for the student to examine and study.

  G. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Examine the design and relationships of the transmission components supplied by the instructor.

  D. Take test.

### INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Dog Gears

    2. TM 2--Constant Mesh Transmission Parts

    3. TM 3--Transmission Gear Types

        4. TM 4--Shifter Mechanisms
        5. TM 5--Drum Shifter Mechanism - Shift Forks
        6. TM 6--Drum Shifter Mechanism - Major Parts
        7. TM 7--Camplate and Shift Quadrant Shifter Mechanism
        8. TM 8--Ball Lock Shifter Mechanism

    D. Test

    E. Answers to test

II. References:

    A. Ocee, Ritch. *Chilton's Motorcycle Troubleshooting Guide.* Radnor, Pennsylvania: Chilton Book Co., 1966.

    B. *Honda 90 Service Manual - Models S90, CL90, CL90L, CD90, C90, and CT90.* Honda Motor Co., Ltd., 1970.

    C. *Suzuki T-500-2 Service Manual.* Suzuki Motor Co., Ltd., 1969.

    D. *Suzuki 350 Parts Catalogue.* Suzuki Motor Co., Ltd., 1969.

    E. *Yamaha Service Manual - Models YGI, YGI-K, YGS-I and MGIT.* Yamaha Motor Co., Ltd.

    F. *Chilton's New Motorcycle Troubleshooting Guide.* Radnor, Pennsylvania: Chilton Book Co., 1973.

# CONSTANT MESH DESIGN
# UNIT I

## INFORMATION SHEET

I. Terms and definitions

   A. Constant mesh--Transmission design in which the gears are engaged at all times

   B. Dog gear--Mechanical device for holding or gripping that consists of a spike, rod, or bar that engages slots or holes in the sides of other gears (Transparency 1)

   C. Mainshaft--Shaft that delivers power from the engine to the gear box

      (NOTE: The mainshaft is also known as the drive shaft or input shaft.)

   D. Countershaft--Shaft that is driven by the mainshaft and delivers power to the chain sprocket

      (NOTE: The countershaft is also known as the driven shaft or output shaft.)

   E. Idler gear--Gear that spins freely on its shaft and is used to transfer motion from one gear to another

   F. Integral gear--Gear machined as one piece with its shaft

II. Parts of constant mesh transmission (Transparency 2)

   A. Mainshaft

   B. Countershaft

   C. Gears

   D. Bearings

   E. Shifter mechanism

   F. Thrust washers and retaining rings

III. System for gear designation

   A. Location

      1. Mainshaft--Signified by M

      2. Countershaft--Signified by C

## INFORMATION SHEET

B. Use--Signified by

1. 1st gear
2. 2nd gear
3. 3rd gear
4. 4th gear
5. 5th gear

Example: M1--Mainshaft 1st gear, C4--Countershaft 4th gear

IV. Types of transmission gears (Transparency 3)

A. Idler

B. Idler dog

C. Sliding dog

D. Integral

V. Types of transmission shifter mechanisms (Transparency 4)

A. Drum

B. Camplate and shift quadrant

C. Ball lock

VI. Important points in transmission construction design (Transparency 2)

A. Consists of two parallel shafts

B. Each shaft carries three, four, or five gears of varying sizes

(NOTE: Number of gears depends on number of speeds in transmission.)

C. Each gear is meshed with a corresponding gear on the opposite shaft

D. Movable gears are splined to their shaft

(NOTE: Gears can slide sideways but cannot rotate independently of shaft.)

## INFORMATION SHEET

E. Movable gears have dogs to engage dogs, or recesses, on adjacent gears

(NOTE: These gears are known as sliding dog gears.)

F. Adjacent gears spin freely on shaft until engaged by sliding dog gears

G. Movable gears are moved by forks which run in circumferential grooves around hub of gear

(NOTE: Number of forks depends on number of speeds in transmission.)

H. All gears can be meshed constantly, but only one gear set will actually be transmitting power

I. When transmission is in neutral, none of the sliding dog gears are engaged and no power is being transmitted

(NOTE: The following points are helpful when considering transmissions:

1. The shafts must remain parallel when the gears are installed
2. First gear drive is usually cut into the shaft itself; no other gear is
3. Splined or fixed gears always mesh with free spinning gears
4. Round dogs against round holes; square dogs against square dogs
5. Double sliding gears need two free spinning gears on the other shaft
6. Sliding gears or fixed gears alternate with free spinning gears, except when this conflicts with previous rules.)

VII. Major parts of drum shifter mechanism (Transparencies 5 and 6)

(NOTE: There are two variations of the drum shifter mechanism. In one the shift forks are supported by the drum, and in the other the shift forks are supported by a separate shaft.)

A. Shifter drum

B. Shift fork

C. Shift lever

## INFORMATION SHEET

D. Shift spindle

E. Shift lever return spring

F. Shift pawl

G. Stopper plate

VIII. Major parts of camplate and shift quadrant shifter mechanism (Transparency 7)

(NOTE: There are two variations of the camplate and shift quadrant shifte mechanism. In one the quadrant is used to rotate the camplate for shifting, and in the other the quadrant serves as the camplate.)

A. Camplate

B. Quadrant

C. Selector forks

D. Index plunger and spring

E. Gear change and plunger assembly

F. Gear pedal

IX. Major parts of ball lock shifter mechanism (Transparency 8)

A. Drive axle

B. Steel balls

C. Shifter head

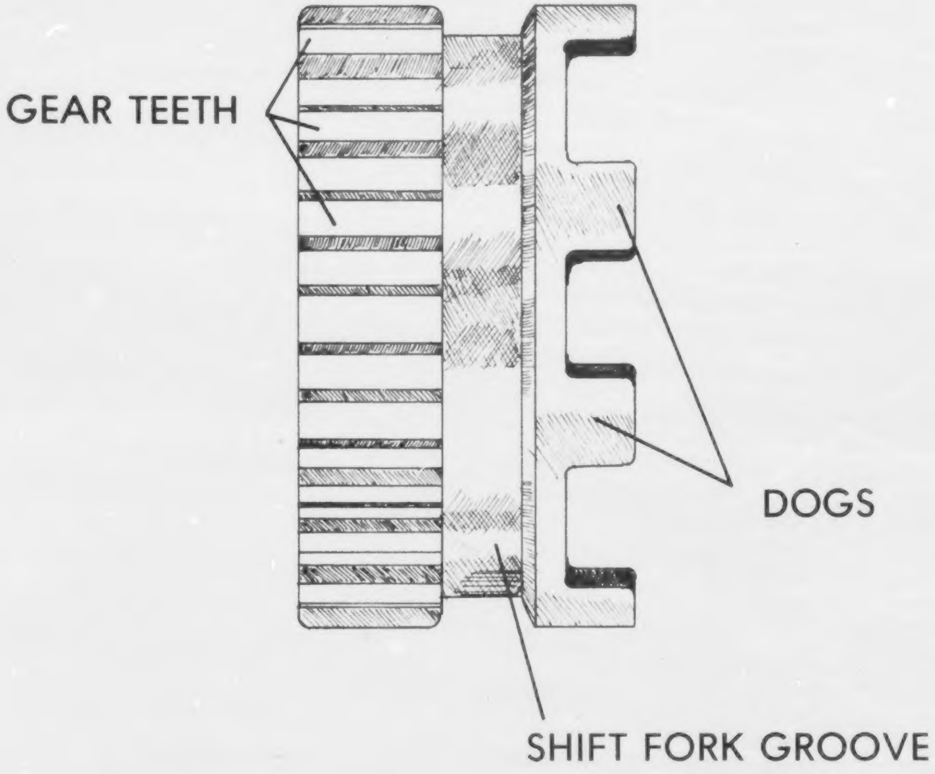
D. Shifter rod

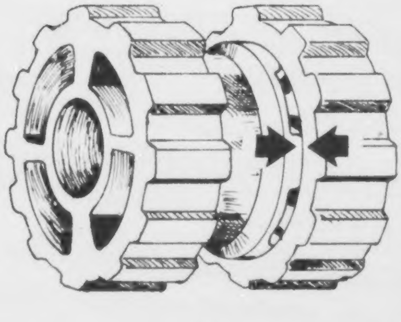
E. Shifter camplate

F. Gear change lever

G. Stop pin and spring

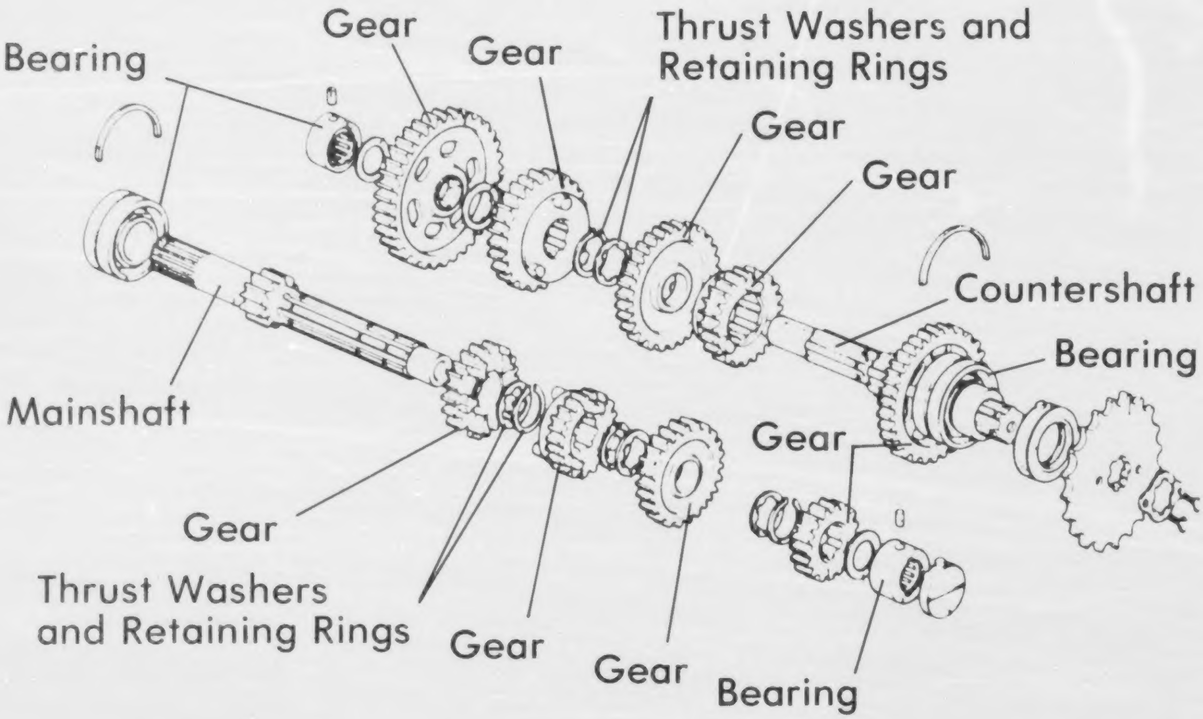
# DOG GEARS

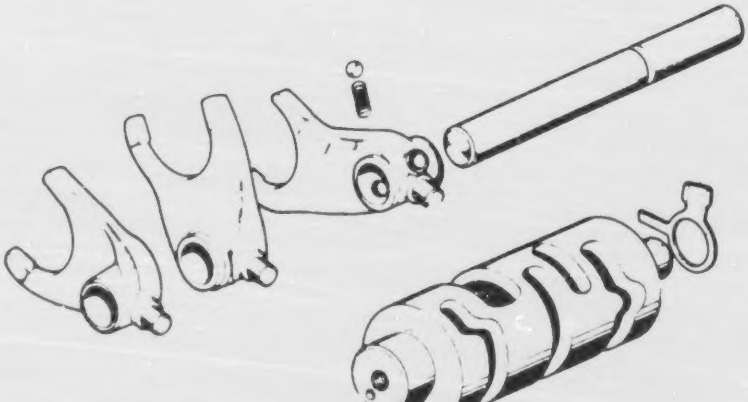

GEAR TEETH
DOGS
SHIFT FORK GROOVE



DURING ENGAGEMENT

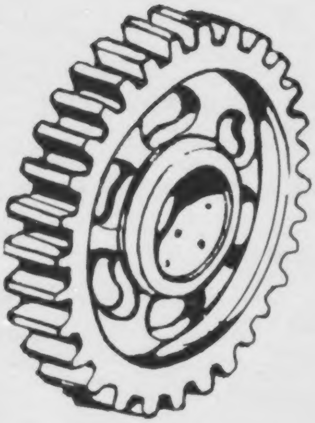
# CONSTANT MESH TRANSMISSION PARTS


Gear
Bearing
Gear
Thrust Washers and Retaining Rings
Gear
Gear
Countershaft
Bearing
Mainshaft
Gear
Gear
Thrust Washers and Retaining Rings
Gear
Gear
Bearing

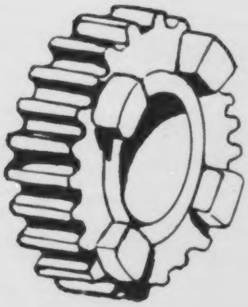


SHIFTER MECHANISM

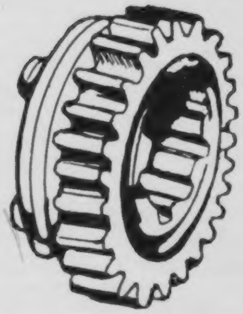
# TRANSMISSION GEAR TYPES



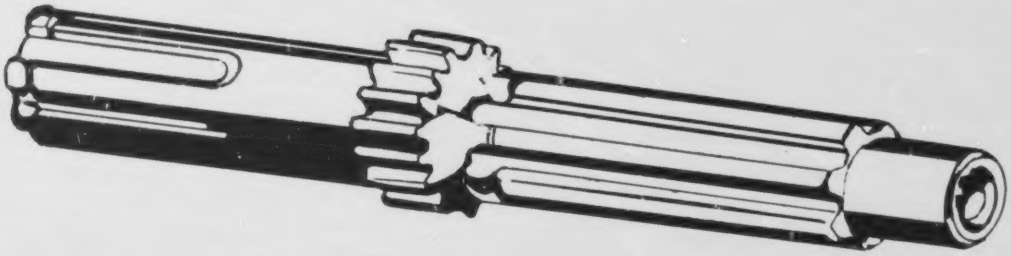
IDLER GEAR



IDLER DOG GEAR



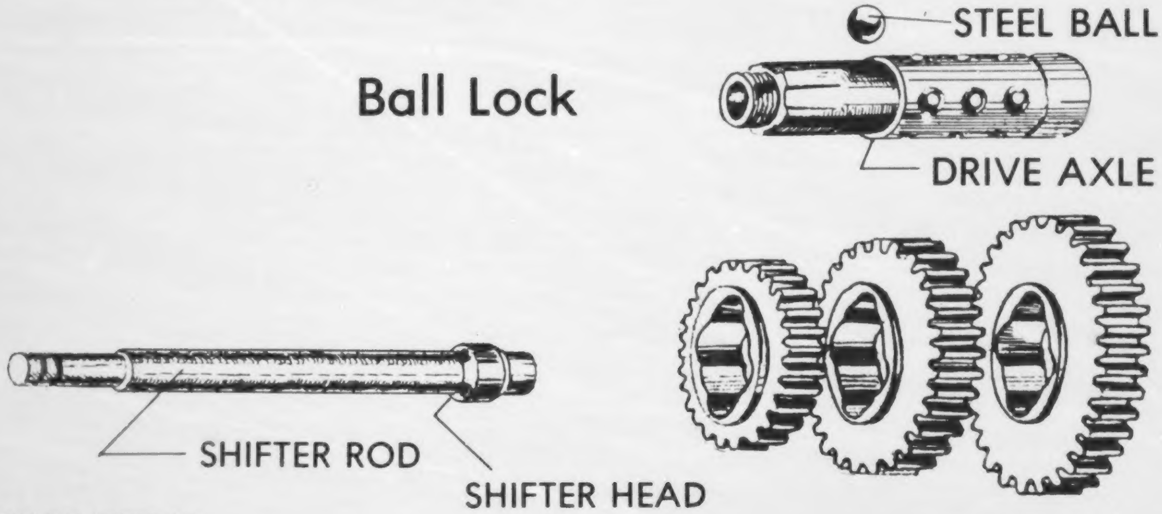
SLIDING DOG GEAR

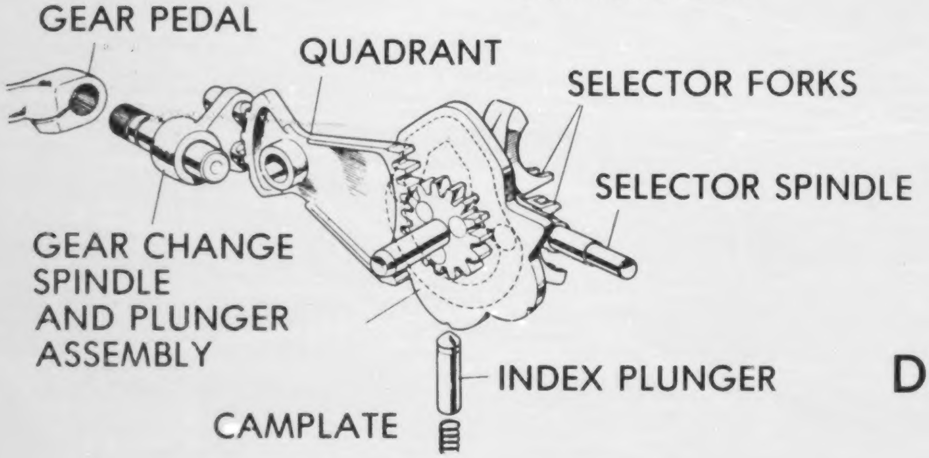


INTEGRAL GEAR

# SHIFTER MECHANISMS

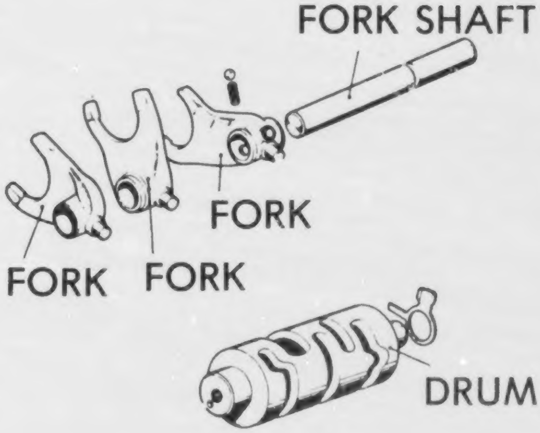
Ball Lock


STEEL BALL
DRIVE AXLE
SHIFTER ROD
SHIFTER HEAD

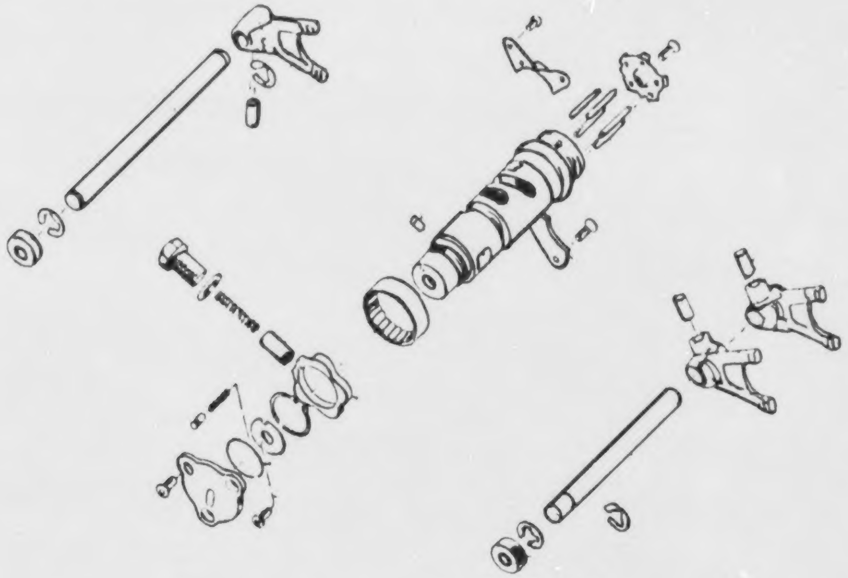

GEAR PEDAL
QUADRANT
SELECTOR FORKS
SELECTOR SPINDLE
GEAR CHANGE SPINDLE AND PLUNGER ASSEMBLY
INDEX PLUNGER
CAMPLATE

Camplate and Shift Quadrant

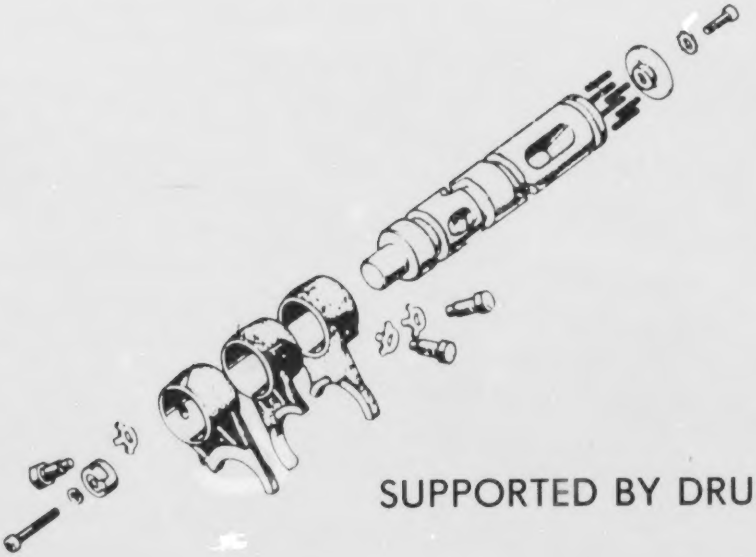
Drum


FORK SHAFT
FORK
FORK
FORK
DRUM

# DRUM SHIFTER MECHANISM-SHIFT FORKS

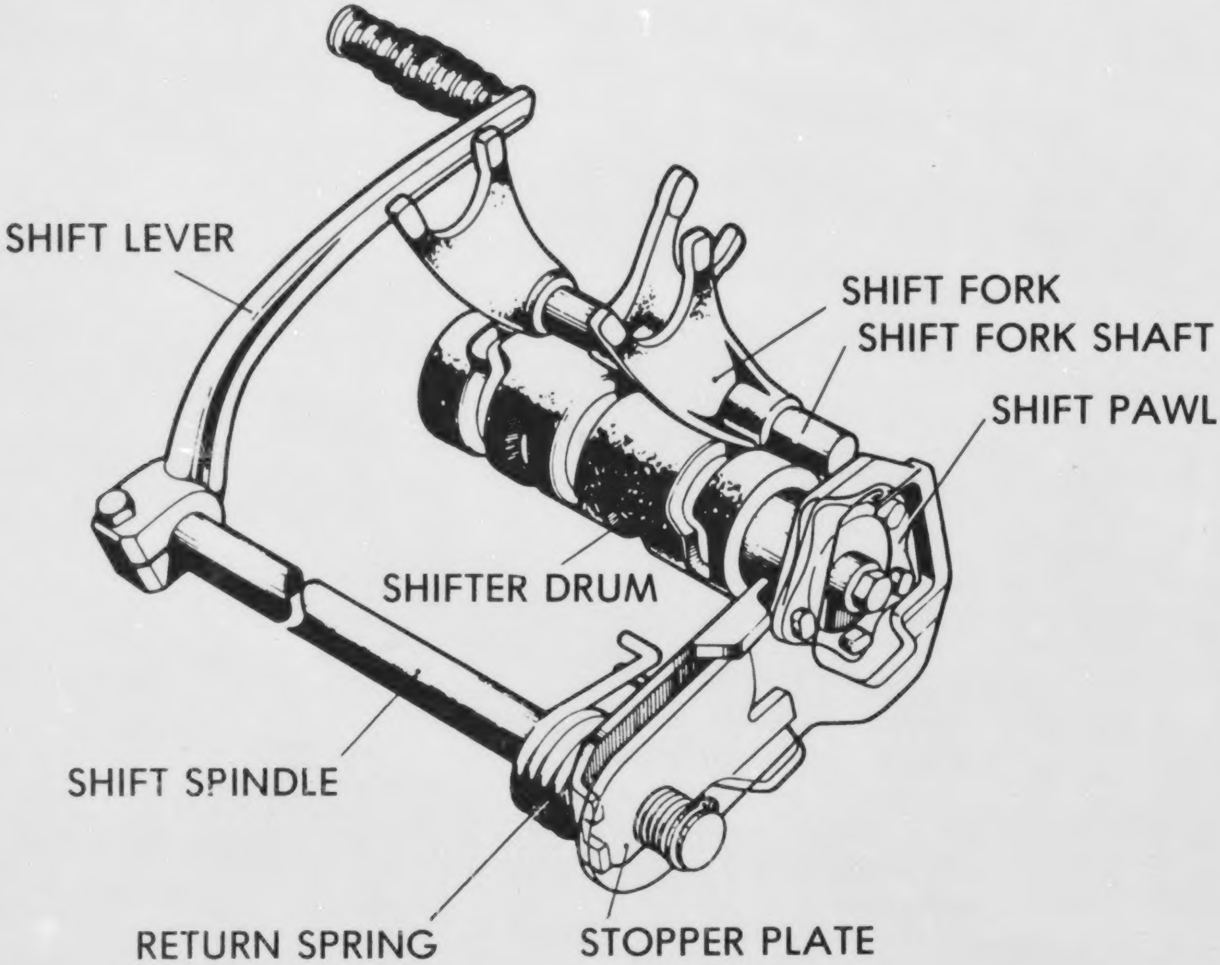


SUPPORTED ON SEPARATE SHAFTS



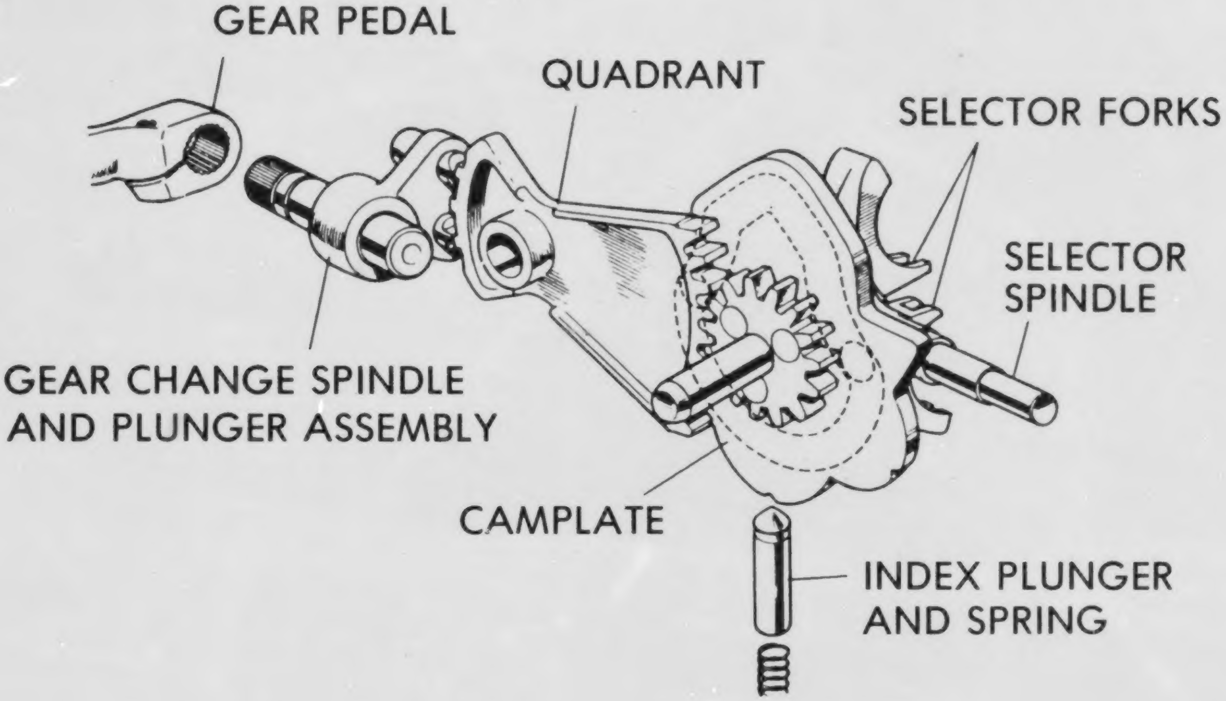
SUPPORTED BY DRUM

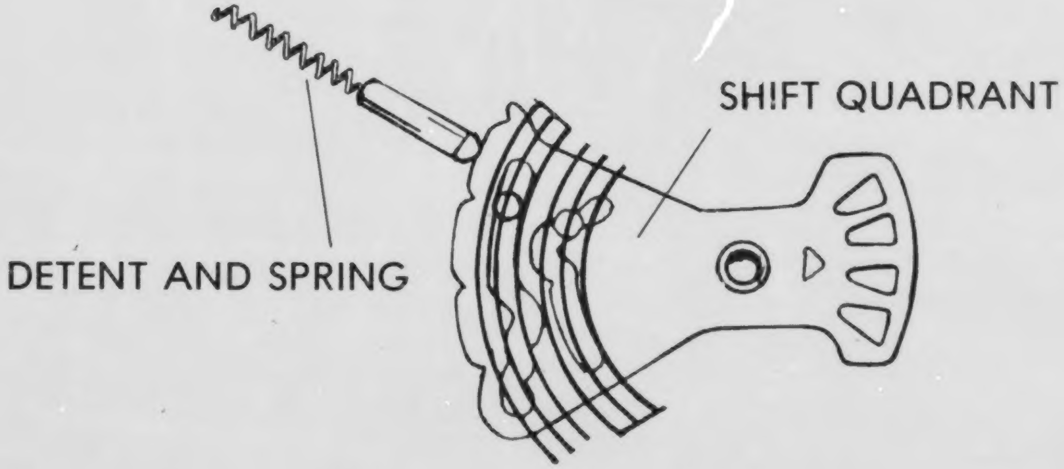
# DRUM SHIFTER MECHANISM-MAJOR PARTS


SHIFT LEVER
SHIFT FORK
SHIFT FORK SHAFT
SHIFT PAWL
SHIFTER DRUM
SHIFT SPINDLE
RETURN SPRING
STOPPER PLATE

Courtesy;
American Honda Motor Co., Inc.
Gardena, California

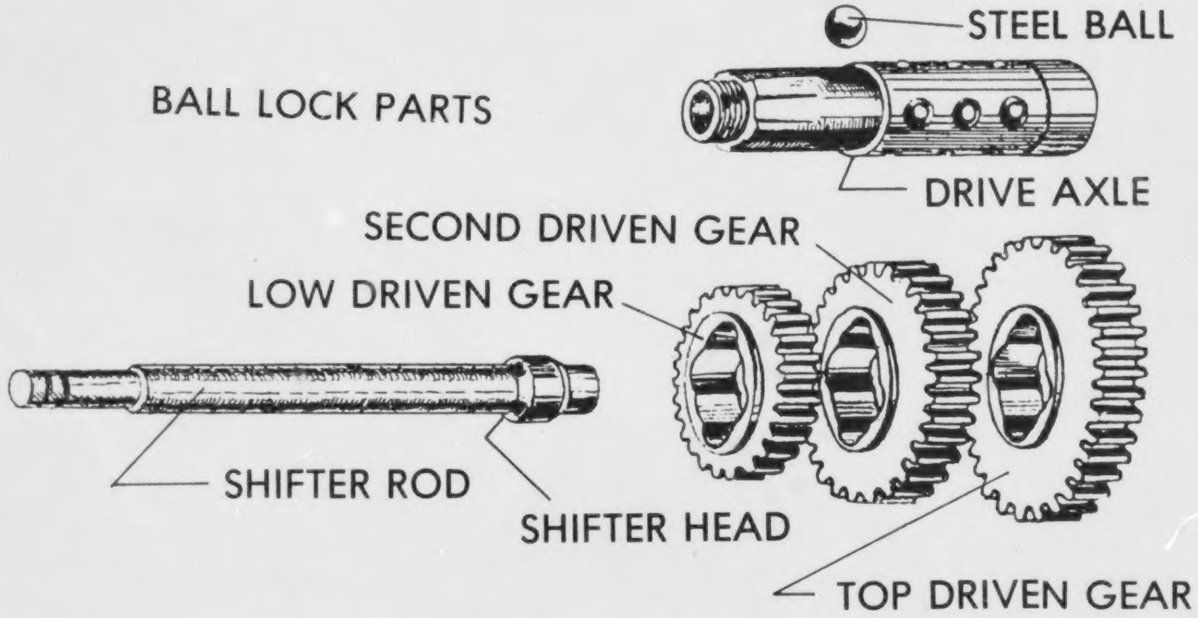
# CAMPLATE AND SHIFT QUADRANT SHIFTER MECHANISM

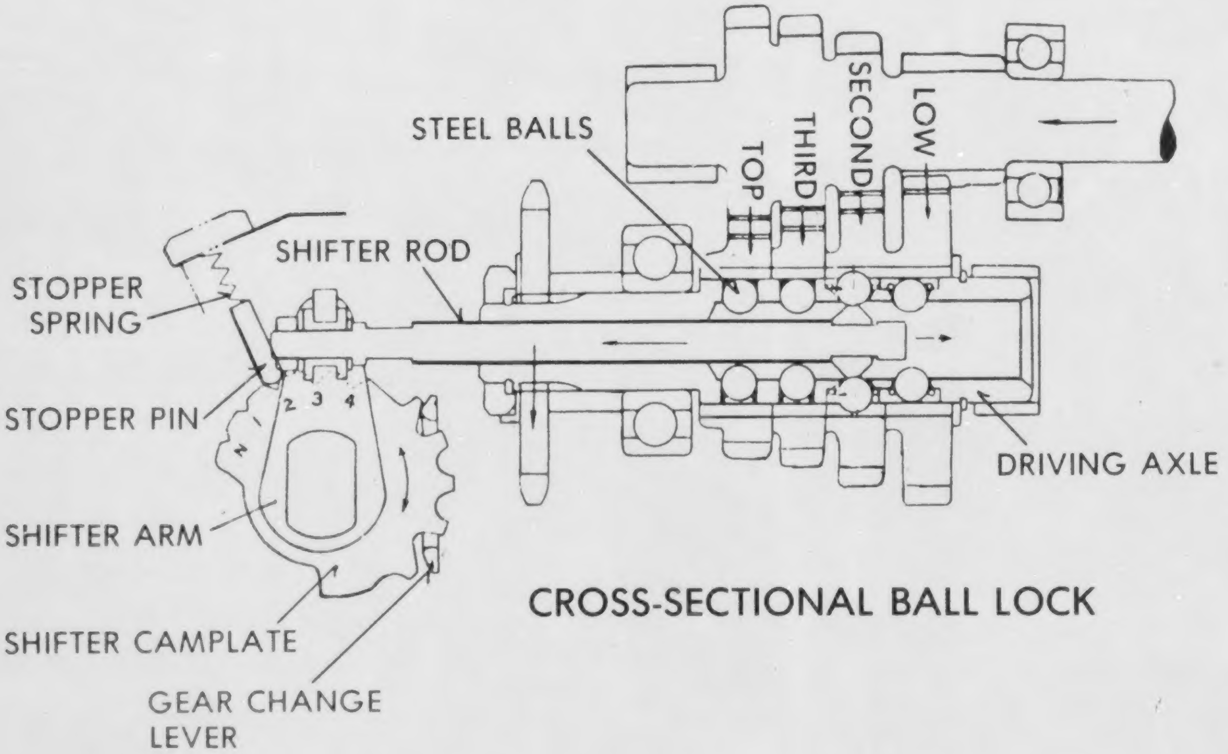

GEAR PEDAL
QUADRANT
SELECTOR FORKS
SELECTOR SPINDLE
GEAR CHANGE SPINDLE AND PLUNGER ASSEMBLY
CAMPLATE
INDEX PLUNGER AND SPRING


SHIFT QUADRANT
DETENT AND SPRING

NOTE: SHIFT QUADRANT IN THIS DESIGN ALSO SERVES AS THE CAMPLATE SINCE IT HAS THE FORK SLOTS CUT INTO IT

# BALL LOCK SHIFTER MECHANISM


BALL LOCK PARTS
STEEL BALL
DRIVE AXLE
SECOND DRIVEN GEAR
LOW DRIVEN GEAR
SHIFTER ROD
SHIFTER HEAD
TOP DRIVEN GEAR


CROSS-SECTIONAL BALL LOCK
STEEL BALLS
TOP
THIRD
SECOND
LOW
SHIFTER ROD
STOPPER SPRING
STOPPER PIN
1
2
3
4
N
SHIFTER ARM
SHIFTER CAMPLATE
GEAR CHANGE LEVER
DRIVING AXLE

## CONSTANT MESH DESIGN
## UNIT I

NAME ______________________

## TEST

1. Match the terms on the right to the correct definitions.

_____a. Gear machined as one piece with its shaft

_____b. Shaft that delivers power from the engine to the gear box

_____c. Gear that spins freely on its shaft and is used to transfer motion from one gear to another

_____d. Transmission design in which the gears are engaged at all times

_____e. Shaft that is driven by the mainshaft and delivers power to the chain sprocket

_____f. Mechanical device for holding or gripping that consists of a spike, rod, or bar that engages slots or holes in the sides of other gears

1. Dog gear
2. Countershaft
3. Constant mesh
4. Integral gear
5. Idler gear
6. Mainshaft

2. Identify the parts of the constant mesh transmission.

   a.

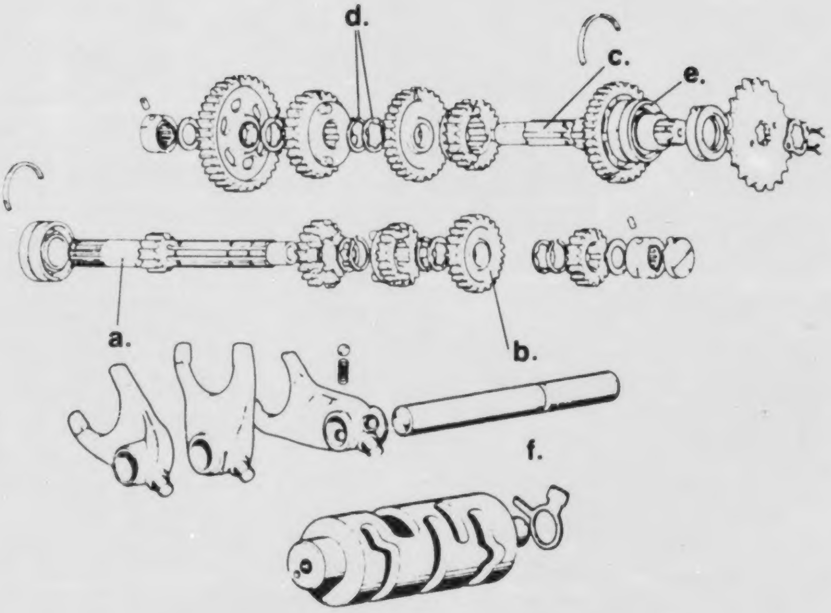
   b.

   c.

   d.

   e.

   f.



3. Describe the system for gear designation.

4. Select the types of transmission gears by placing an "X" in the appropriate blanks.

_____a. Integral

_____b. Close ratio

_____c. Helical

_____d. Idler dog

_____e. Hypoid

_____f. Idler

_____g. Siiding dog

5. Select the types of transmission shifter mechanisms by placing an "X" in the appropriate blanks.

_____a. Hurst syncro-lok

_____b. Camplate and shift quadrant

_____c. Vacuum assist

_____d. Ball lock

_____e. Dual diaphragm

_____f. Drum

6. List eight important points in transmission construction design.

a.

b.

c.

d.

e.

f.

g.

h.

7. List the major parts of a drum shifter mechanism.

   a.

   b.

   c.

   d.

   e.

   f.

   g.

8. Select the major parts of a camplate and shift quadrant shifter mechanism by placing an "X" in the appropriate blanks.

   ______a. Camplate

   ______b. Shift pawl

   ______c. Gear pedal

   ______d. Index plunger and spring

   ______e. Shifter drum

   ______f. Quadrant

   ______g. Selector forks

   ______h. Steel balls

   ______i. Gear change and plunger assembly

9. List the major parts of the ball lock shifter mechanism.

   a.

   b.

   c.

   d.

   e.

   f.

   g.

## CONSTANT MESH DESIGN
## UNIT I

## ANSWERS TO TEST

1.
   - a. 4
   - b. 6
   - c. 5
   - d. 3
   - e. 2
   - f. 1
2.
   - a. Mainshaft
   - b. Gears
   - c. Countershaft
   - d. Thrust washers and retaining rings
   - e. Bearings
   - f. Shifter mechanism
3. Description should include:
   - a. Location
     - 1) Mainshaft--Signified by M
     - 2) Countershaft--Signified by C
   - b. Use--Signified by
     - 1) 1st gear
     - 2) 2nd gear
     - 3) 3rd gear
     - 4) 4th gear
     - 5) 5th gear
4. a, d, f, g
5. b, d, f

6. Any eight of the following:
   - a. Consists of two parallel shafts
   - b. Each shaft carries three, four, or five gears of varying sizes
   - c. Each gear is meshed with a corresponding gear on the opposite shaft
   - d. Movable gears are splined to their shaft
   - e. Movable gears have dogs to engage dogs, or recesses, on adjacent gears
   - f. Adjacent gears spin freely on shaft until engaged by sliding dog gears
   - g. Movable gears are moved by forks which run in circumferential grooves around hub of gear
   - h. All gears can be meshed constantly, but only one gear set will actually be transmitting power
   - i. When transmission is in neutral, none of the sliding dog gears are engaged and no power is being transmitted

7. a. Shifter drum
   - b. Shift fork
   - c. Shift lever
   - d. Shift spindle
   - e. Shift lever return spring
   - f. Shift pawl
   - g. Stopper plate

8. a, c, d, f, g, i

9. a. Drive axle
   - b. Steel balls
   - c. Shifter head
   - d. Shifter rod
   - e. Shifter camplate
   - f. Gear change lever
   - g. Stop pin and spring

# CONSTANT MESH OPERATION
## UNIT II

## UNIT OBJECTIVE

After completion of this unit, the student should be able to distinguish between the two gear shift patterns and match the types of shifter mechanisms to the correct operations. The student should also be able to calculate gear ratios and trace the power flow through the transmission in each of the gear combinations. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define gear ratio.
2. Distinguish between the two gear shift patterns.
3. Match the types of shifter mechanisms to the correct operations.
4. Trace the power flow through the transmission in the gear combinations.
5. Calculate gear ratios.

# CONSTANT MESH OPERATION
# UNIT II

## SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and assignment sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information and assignment sheets.

  F. Construct a mock-up from an old transmission and demonstrate the shift patterns and operation of the shifter mechanisms.

  G. Demonstrate the different gear ratios by counting the number of revolutions of the input shaft to one revolution of the output shaft.

  H. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Complete assignment sheet.

  D. Complete activities assigned by instructor.

  E. Observe and participate in any demonstration given by instructor.

  F. Take test.

## INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

C. Transparency masters

1. TM 1--Gear Shift Patterns
2. TM 2--Operation of Shifter Mechanism
3. TM 3--Drum Shifter Mechanism-Pawl Variations
4. TM 4--Camplate and Shift Quadrant Shifter Mechanism
5. TM 5--Ball Lock Shifter Mechanism
6. TM 6--First Gear-Transmission Power Flow
7. TM 7--Second Gear-Transmission Power Flow
8. TM 8--Third Gear-Transmission Power Flow
9. TM 9--Fourth Gear-Transmission Power Flow
10. TM 10--Fifth Gear-Transmission Power Flow
11. TM 11--Neutral

D. Assignment Sheet #1--Calculate Gear Ratios

E. Answers to assignment sheet

F. Test

G. Answers to test

II. References:

A. *Yamaha Service Manual-Models YGI, YGI-K, YGS-I, and MGIT.* Yamaha Motor Co., Ltd.

B. *Honda 250-350 Service Manual.* Honda Motor Co., Ltd., 1972.

C. *Honda 450 Service Manual.* Honda Motor Co., Ltd., 1971.

D. *Motorcycle Systems Training Manual-Motorcycle Power Train.* Kawasaki Motors Corp., 1973.

E. Nicholson, J. B. *Modern Motorcycle Mechanics.* 7th ed. Saskatoon, Saskatchewan, Canada: Nicholson Brothers Motorcycles, Ltd., 1974.

F. *Chilton's New Motorcycle Troubleshooting Guide.* Radnor, Pennsylvania: Chilton Book Co., 1973.

## CONSTANT MESH OPERATION
## UNIT II

### INFORMATION SHEET

I. Gear ratio--Number of teeth on countershaft gear in relation to number of teeth on mainshaft gear

(NOTE: Gear ratio is also referred to as the speed of the input shaft in relation to the speed of the output shaft.)

II. Gear shift patterns (Transparency 1)

A. Standardized--1st gear down from neutral and 2nd, 3rd, 4th, and 5th gears up from neutral

(NOTE: This is the most common shift pattern.)

B. Early British--1st gear up from neutral and 2nd, 3rd, and 4th gears down from neutral

III. Operations of types of shifter mechanisms (Transparency 2)

A. Drum shifter mechanism (Transparency 3)

1. Shift pedal moved up or down

a. Shift pawl moves

b. Return spring spreads applying reverse pressure on pedal

c. Pawl contacts drum pin causing drum to rotate

2. Drum rotation

a. Forks move sideways because pins in forks must follow grooves in drum

b. Forks move sliding gears on transmission shafts

c. Stop pawl or stop "hooks" limit the rotation of drum for each shift

d. Each gear change requires only a few degrees of rotation of the drum

e. Detent holds drum in correct position between shifts

(NOTE: Shift pawls and stop pawls are manufactured in many configurations.)

## INFORMATION SHEET

3. Shift pedal released
    a. Return spring moves pedal back to central position
    b. Pawl returns to central position, ready to shift either up or down

B. Camplate and shift quadrant shifter mechanism (Transparency 4)

1. Shift pedal moved up or down
    a. Gear change spindle and plunger assembly rotates
    b. Plungers engage teeth on the quadrant
    c. Quadrant pivots to rotate camplate
    d. Shift forks follow slots cut in camplate
2. Shift pedal released
    a. Return spring moves pedal back to central position
    b. Index plunger holds camplate and quadrant in position between shifts

    (NOTE: There are two variations of the camplate and shift quadrant shifter mechanism, but the operations are basically the same.)

C. Ball lock shifter mechanism (Transparency 5)

1. Shift pedal moved up or down
    a. Rotates shifter camplate
    b. Camplate moves shifter rod in or out of hollow countershaft
    c. Shifter head forces steel ball outward
    d. Steel balls engage slots in inner surfaces of gears
    e. Stop pin and spring engage notches in camplate to maintain shifter position
2. Shift pedal released
    a. Return spring moves shift pedal back to central position
    b. Camplate and shift rod do not return to a central position for the next shift

## INFORMATION SHEET

IV. Transmission power flow

(NOTE: Refer to appropriate service manual to determine gear numbering and location of gears moved when shifting.)

A. First gear (Transparency 6)

1. C-4 is moved to engage C-1
2. M-1 and C-1 are in constant mesh
3. C-4 splined to countershaft
4. Power flow is mainshaft to M-1 to C-1 to C-4 to countershaft

B. Second gear (Transparency 7)

1. C-5 is moved to engage C-2
2. M-2, M-3 made as a single unit
3. M-2, M-3 splined to countershaft
4. Power flow is mainshaft to M-2 and 3 to C-2 to C-5 to countershaft

C. Third gear (Transparency 8)

1. C-4 is moved to engage C-3
2. Power flow is mainshaft to M-2 and 3 to C-3 to C-4 to countershaft

D. Fourth gear (Transparency 9)

1. M-2 and 3 is moved to engage M-4
2. Power flow is mainshaft to M-2 and 3 to M-4 to C-4 to countershaft

E. Fifth gear (Transparency 10)

1. M-2 and 3 is moved to engage M-5
2. M-5 is meshed to C-5
3. C-5 is splined to countershaft
4. Power flow is mainshaft to M-2 and 3 to M-5 to C-5 to countershaft

## INFORMATION SHEET

F. Neutral (Transparency 11)

1. Sliding gears C-4, C-5, and M-2 and 3 are centered

2. No power flows from mainshaft to countershaft

(NOTE: Shifting C-4 will give 1st and 3rd gears, shifting C-5 will give 2nd gear, and shifting M-2 and 3 will give 4th and 5th gears.)

V. Calculating gear ratios

A. Enter number of teeth on countershaft (driven shaft or output shaft) gear

B. Enter number of teeth on mainshaft (drive shaft or input shaft ) gear

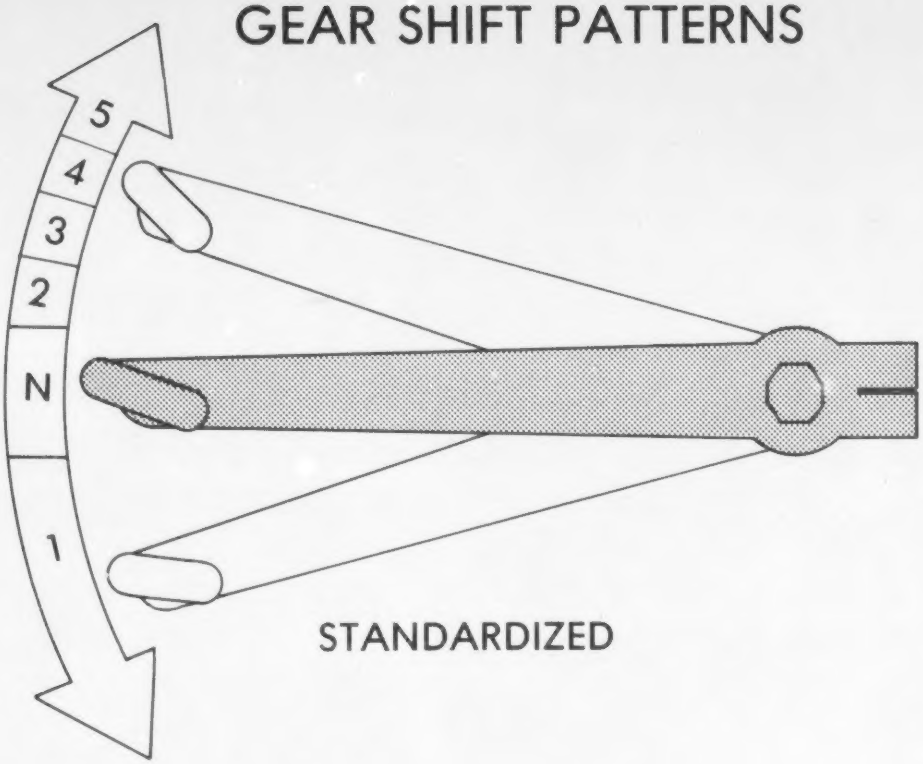
Example: Countershaft gear, 60 teeth; mainshaft gear, 25 teeth; ratio is 60:25

C. Reduce numbers to fractions by dividing each number by the smallest of the two numbers

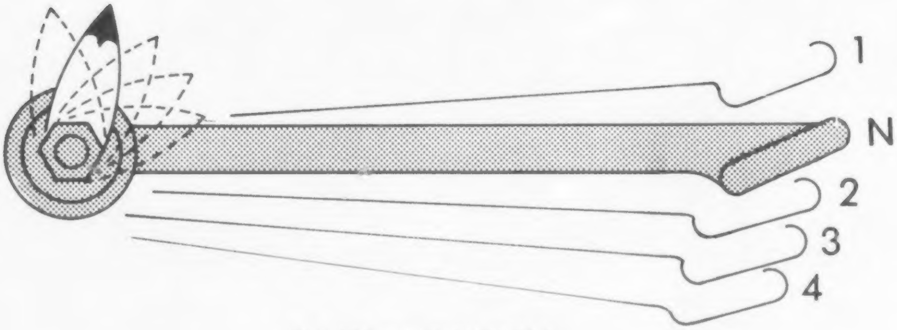
Example: If ratio is 60:25, 25 is the smallest of the two numbers; therefore, 60 ÷ 25 = 2.4 and 25 ÷ 25= 1. Ratio is 2.4:1

(NOTE: In the example the input shaft is rotating 2.4 times for every 1 revolution of the output shaft, or the input shaft is 2.4 times faster than the output shaft.)

# GEAR SHIFT PATTERNS

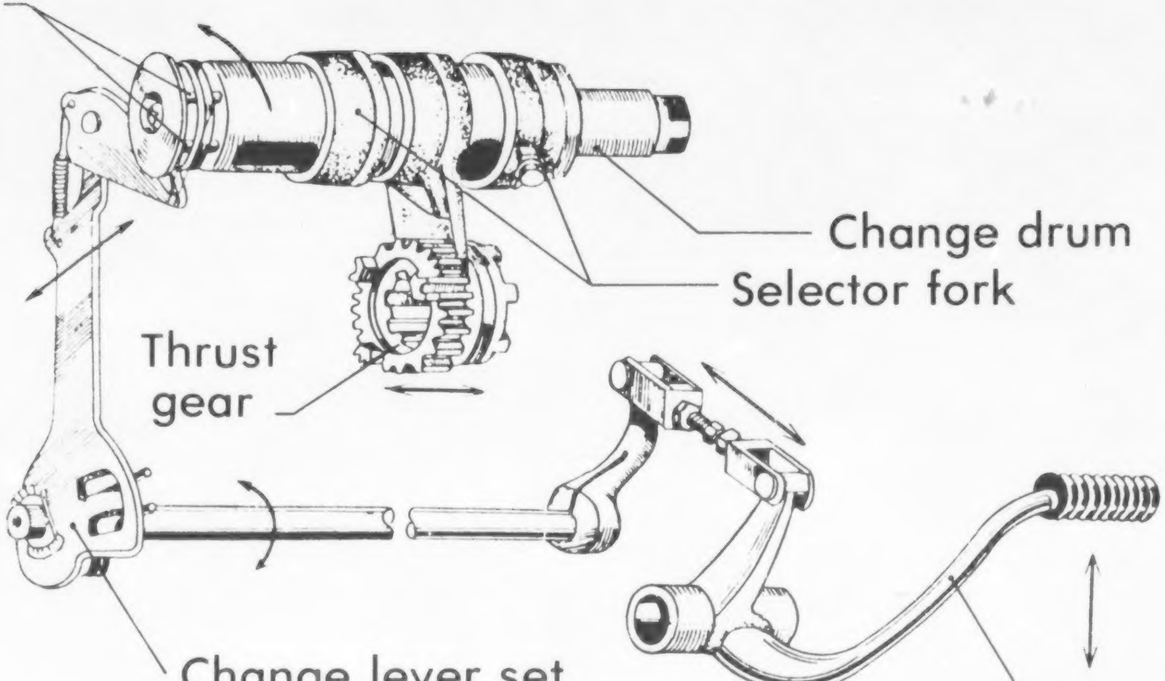


STANDARDIZED



EARLY BRITISH

# OPERATION OF SHIFTER MECHANISM

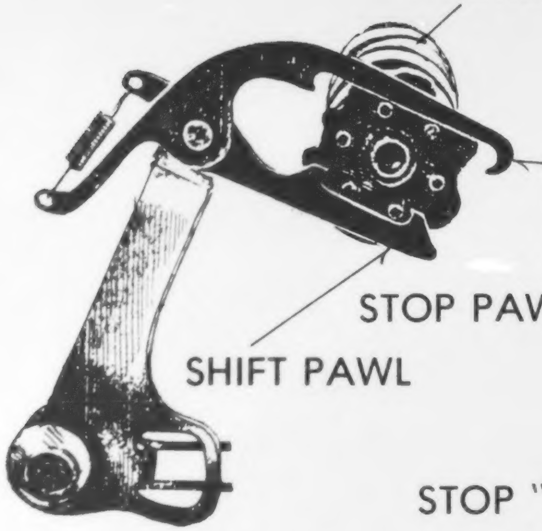

Drum pin
Change drum
Selector fork
Thrust gear
Change lever set
Change pedal

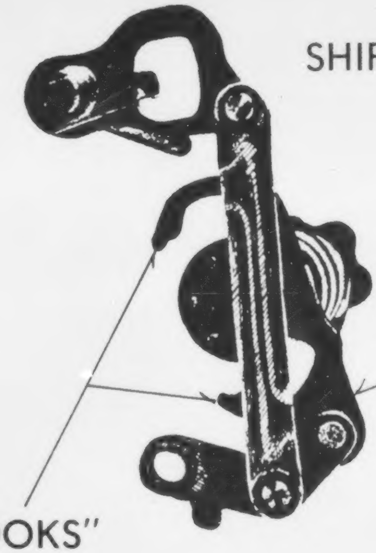
TM - 2

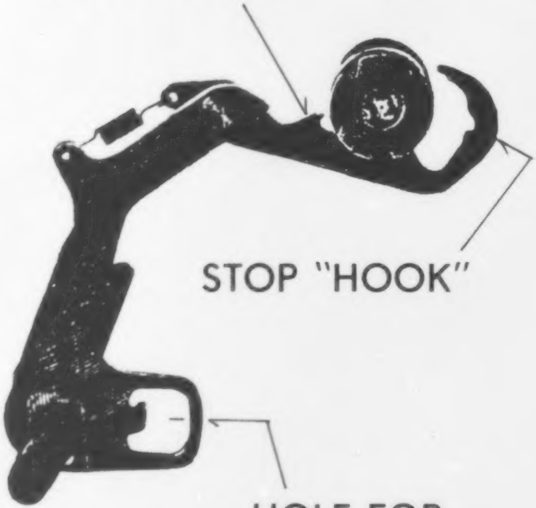
173

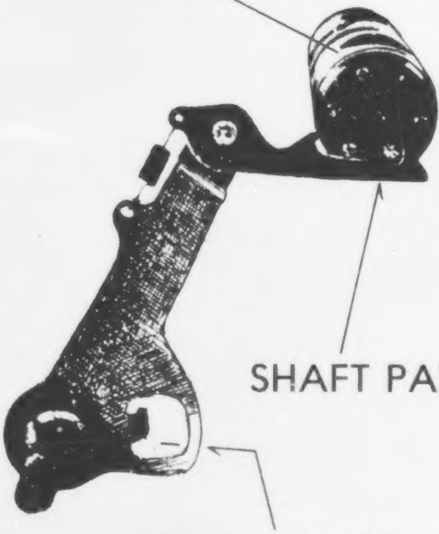
M - 41-C

# DRUM SHIFTER MECHANISM
## Pawl Variations

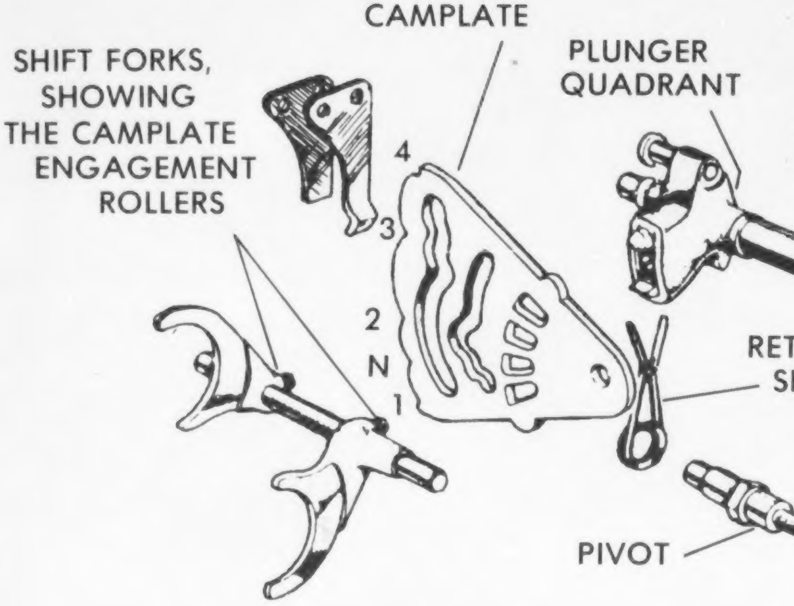

DRUM
STOP PAWL
SHIFT PAWL


SHIFT PAWL
STOP "HOOKS"

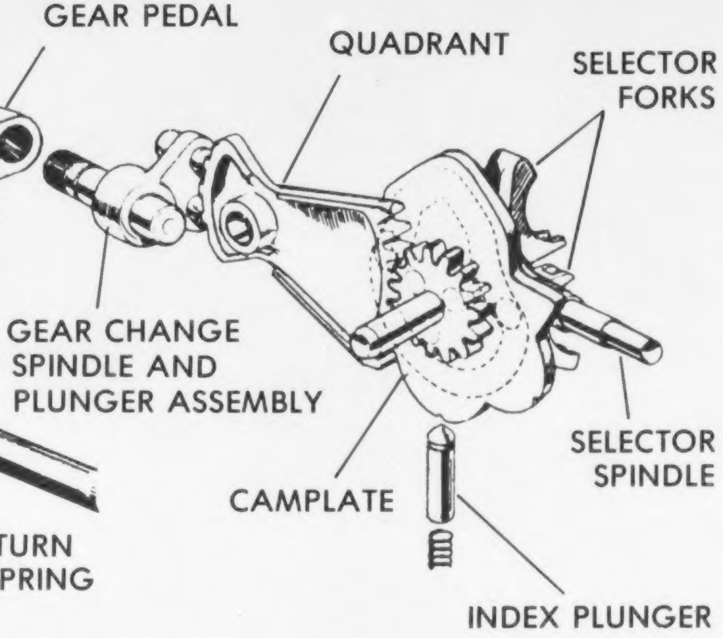

SHIFT PAWL
STOP "HOOK"
HOLE FOR RETURN SPRING PIN


DRUM
SHAFT PAWL
HOLE FOR RETURN SPRING PIN

# CAMPLATE AND SHIFT QUADRANT SHIFTER MECHANISM


CAMPLATE
SHIFT FORKS, SHOWING THE CAMPLATE ENGAGEMENT ROLLERS
PLUNGER QUADRANT
4
3
2
N
1
RETURN SPRING
PIVOT

BSA shifter mechanism

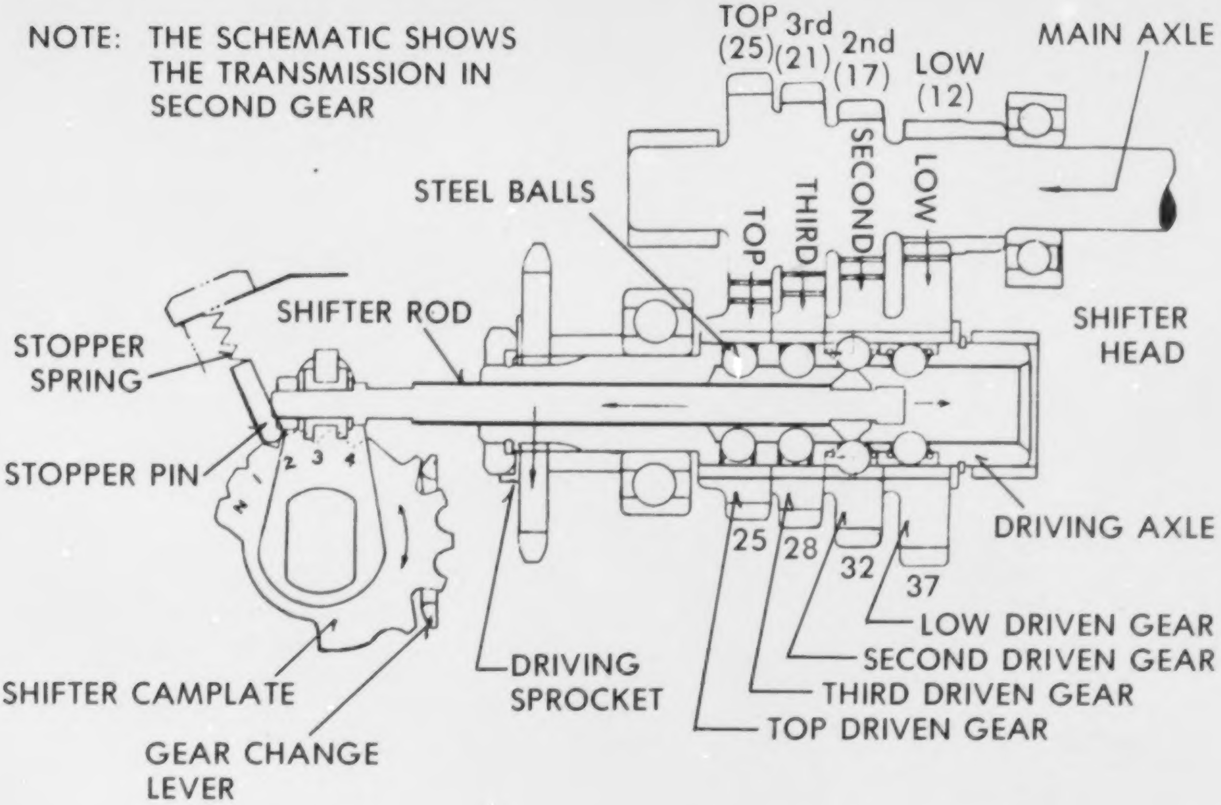

GEAR PEDAL
QUADRANT
SELECTOR FORKS
GEAR CHANGE SPINDLE AND PLUNGER ASSEMBLY
CAMPLATE
SELECTOR SPINDLE
INDEX PLUNGER

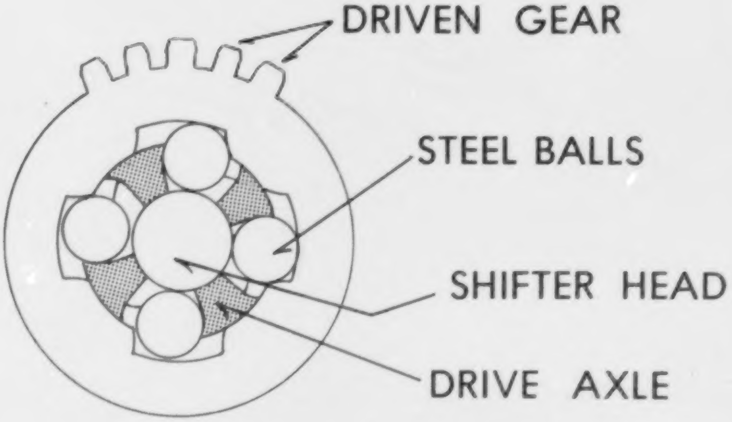
Camplate type shifter mechanism from a Triumph Trident

ILLUSTRATIONS BY NORTON-TRIUMPH CORPORATION

# BALL LOCK SHIFTER MECHANISM

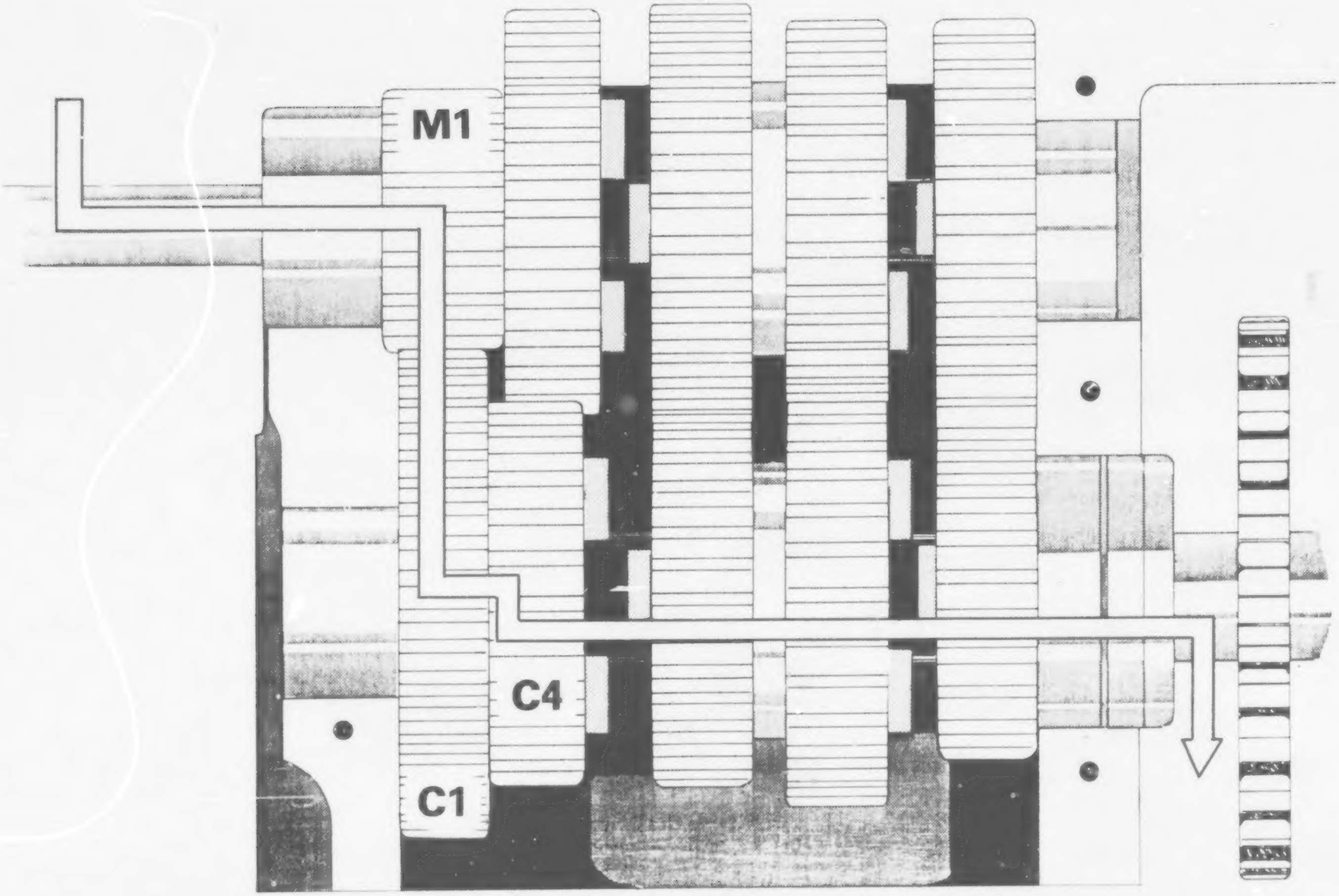
NOTE: THE SCHEMATIC SHOWS THE TRANSMISSION IN SECOND GEAR


TOP (25)
3rd (21)
2nd (17)
LOW (12)
MAIN AXLE
SECOND
THIRD
TOP
LOW
STEEL BALLS
SHIFTER ROD
STOPPER SPRING
STOPPER PIN
2 3 4
N
SHIFTER HEAD
DRIVING AXLE
25
28
32
37
LOW DRIVEN GEAR
SECOND DRIVEN GEAR
THIRD DRIVEN GEAR
TOP DRIVEN GEAR
DRIVING SPROCKET
SHIFTER CAMPLATE
GEAR CHANGE LEVER


DRIVEN GEAR
STEEL BALLS
SHIFTER HEAD
DRIVE AXLE

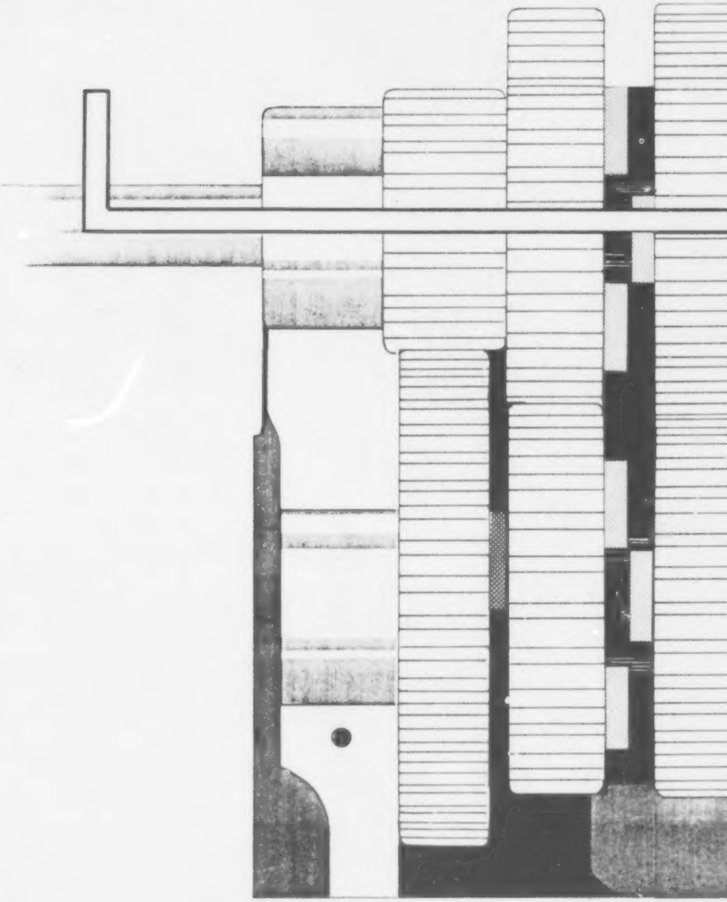
Cross-sectional View

# First Gear-Transmission Power Flow



LOW GEAR (C4 is shifted)

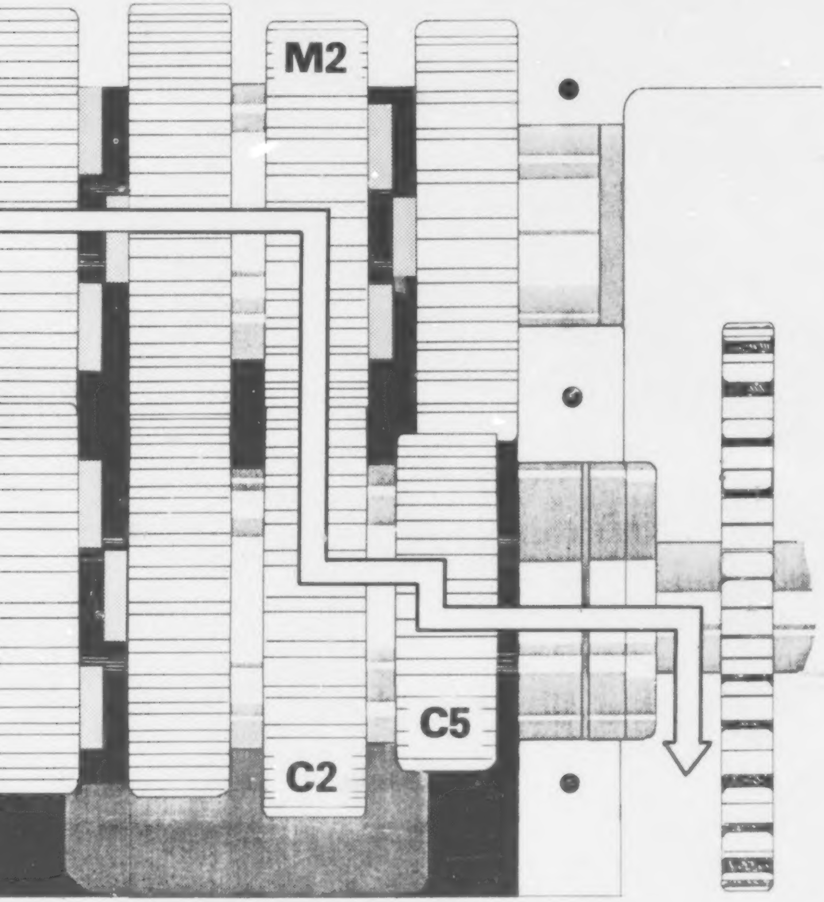
# SECOND GEAR-TRANSM



SECOND GEAR (C5 is

TM - 7

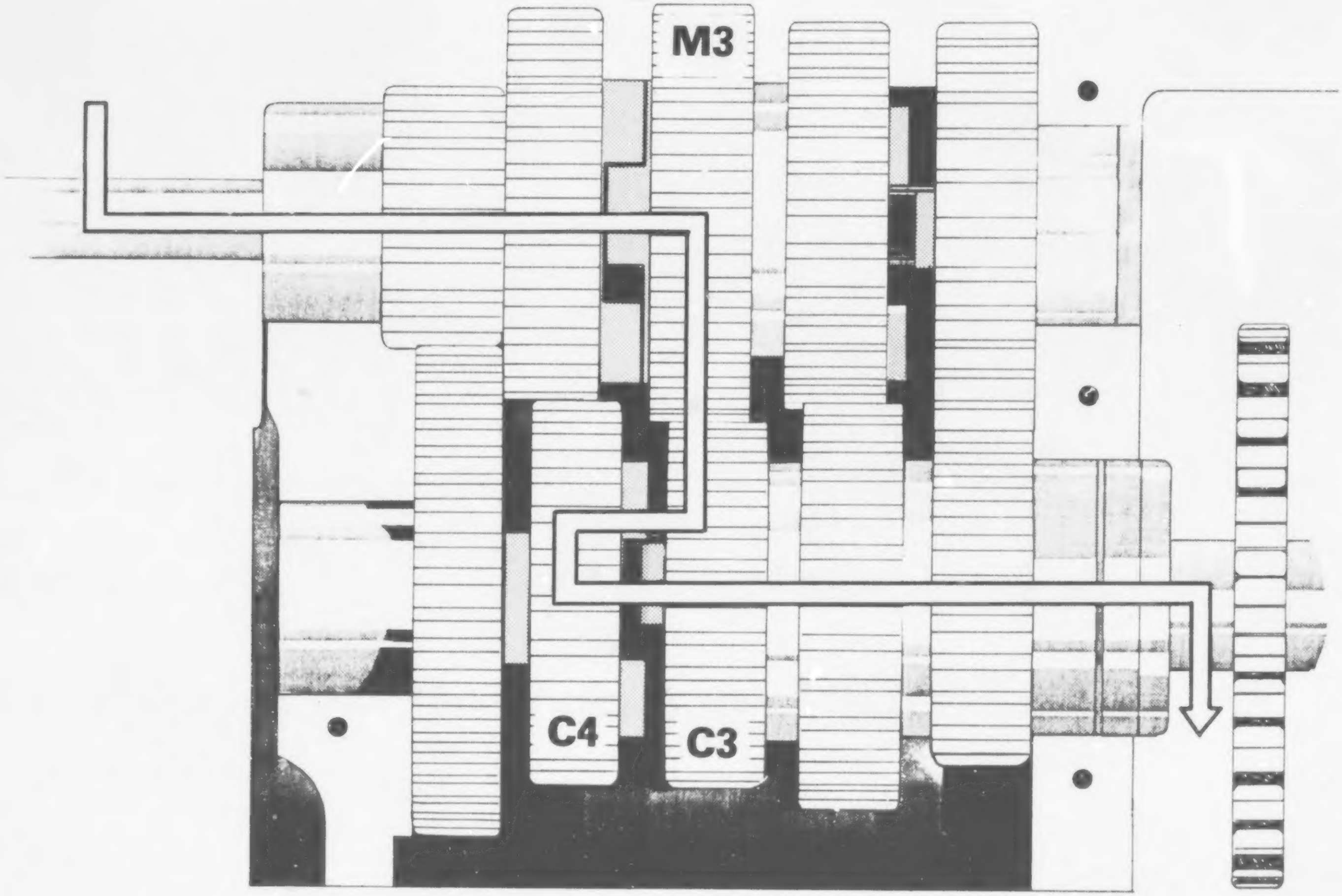
## –TRANSMISSION POWER FLOW



GEAR (C5 is shifted)

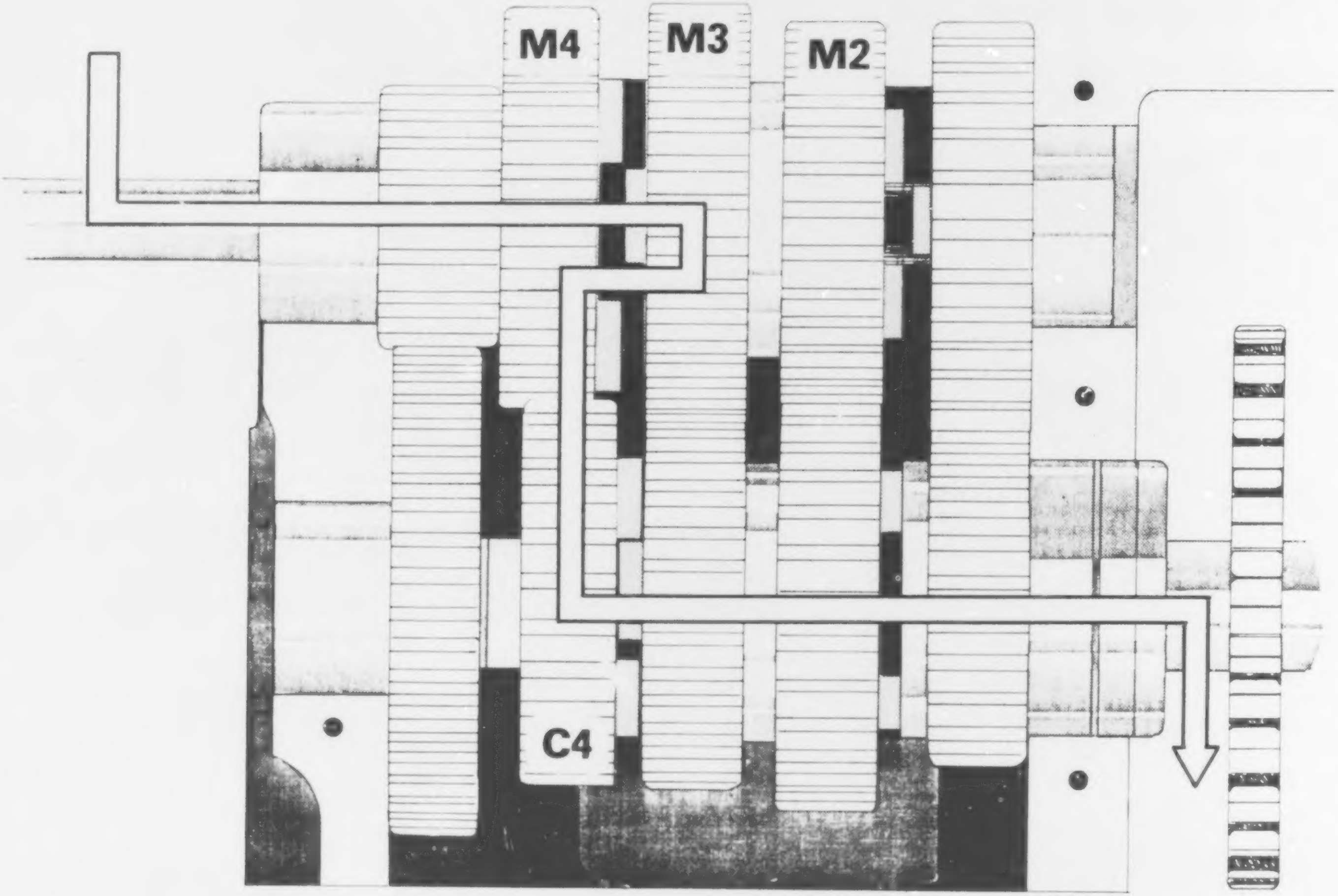
M - 51-C

# THIRD GEAR-TRANSMISSION POWER FLOW



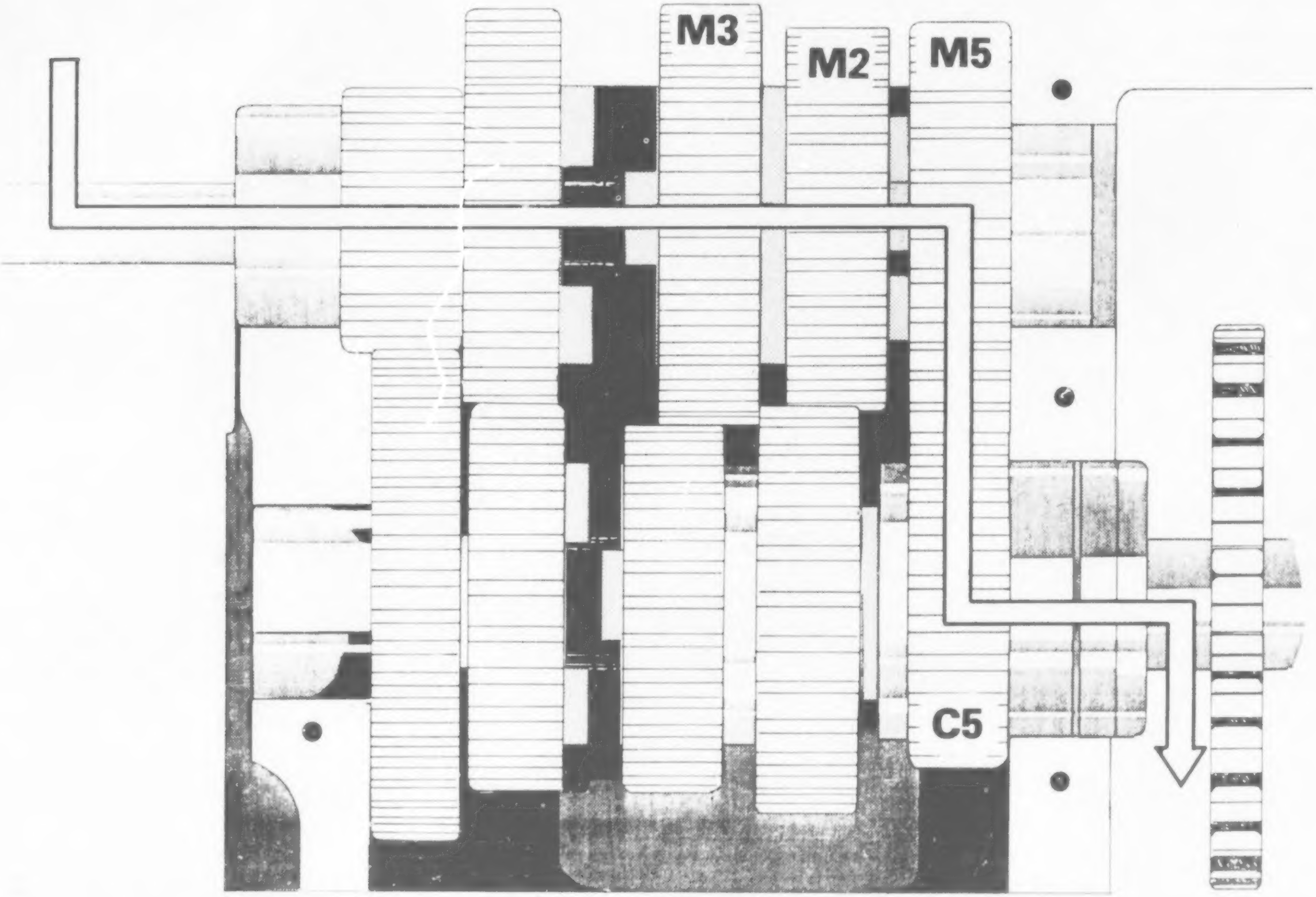
THIRD GEAR (C4 is shifted)

# FOURTH GEAR-TRANSMISSION POWER FLOW



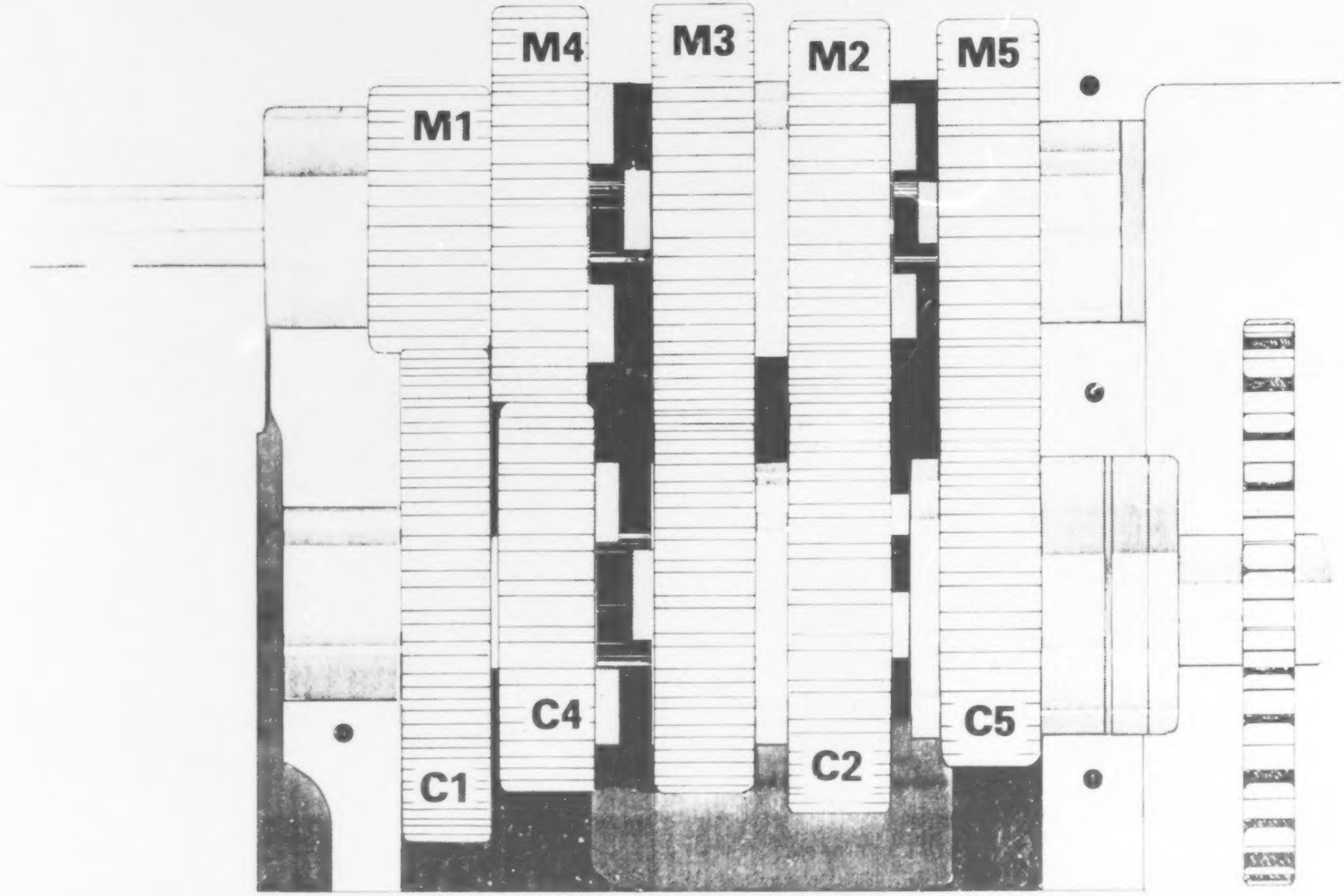
FOURTH GEAR (M2-M3 is shifted)

# FIFTH GEAR-TRANSMISSION POWER FLOW



FIFTH GEAR (M2-M3 is shifted)

## NEUTRAL


M4
M3
M2
M5
M1
C4
C5
C2
C1

NEUTRAL

TM - 11

M - 59-C

# CONSTANT MESH OPERATION
## UNIT II

## ASSIGNMENT SHEET #1--CALCULATE GEAR RATIOS

1. The drive gear has 17 teeth and the driven gear has 43 teeth. What is the gear ratio? Round to two decimal places.

2. In 4th gear a motorcycle has 25 teeth on the mainshaft gear and 25 teeth on the countershaft gear. What is the gear ratio?

## ASSIGNMENT SHEET #1

3. A motorcycle has a gear ratio of 2.4 to 1 in 3rd gear. If the input shaft is turning 2200 RPM, how fast is the output shaft turning? Round to two decimal places.

4. Brand X motorcycle is equipped with a second gear that has 21 teeth on M-2 and 38 teeth on C-2. A tachometer connected to the input shaft indicates it is turning 4700 RPM. What is the speed of the output shaft? Round to two decimal places for ratio and output shaft speed.

# CONSTANT MESH OPERATION
## UNIT II

## ANSWERS TO ASSIGNMENT SHEET

1. 43:17

$$\frac{43}{17} : \frac{17}{17} = \begin{array}{r} 2.529 \\ 17\overline{)43.000} \\ 34 \\ 90 \\ 85 \\ 50 \\ 34 \\ 160 \\ 153 \\ 7/17 \text{ remainder} \end{array} : \begin{array}{r} 1 \\ 17\overline{)17} \\ 17 \end{array}$$

Rounded to two decimal places--Ratio = 2.53:1

2. 25:25

$$\frac{25}{25} : \frac{25}{25} = \begin{array}{r} 1 \\ 25\overline{)25} \\ 25 \end{array} : \begin{array}{r} 1 \\ 25\overline{)25} \\ 25 \end{array}$$

Ratio = 1:1

3. 2.4 to 1 means input shaft is turning 2.4 times faster than output shaft

$$\begin{array}{r} 916.666 \\ 2.4\overline{)2200.0000} \\ 216 \\ 40 \\ 24 \\ 160 \\ 144 \\ 160 \\ 144 \\ 160 \\ 144 \\ 160 \\ 144 \\ 16/24 \text{ remainder} \end{array}$$

Rounded to two decimal places--Output shaft speed = 916.67 RPM

4. 38:21

$$\frac{38}{21} : \frac{21}{21} = \begin{array}{r} 1.809 \\ 21\overline{)38.000} \\ 21 \\ 170 \\ 168 \\ 20 \\ 0 \\ 200 \\ 189 \\ 11/21 \text{ remainder} \end{array} : \begin{array}{r} 1 \\ 21\overline{)21} \\ 21 \end{array}$$

Rounded to two decimal places--Ratio = 1.81:1

1.81 to 1 means input shaft is turning 1.81 times faster than output shaft

$$\begin{array}{r} 2596.685 \text{ RPM} \\ 1.81\overline{)4700.00000} \\ 362 \\ 1080 \\ 905 \\ 1750 \\ 1629 \\ 1210 \\ 1086 \\ 1240 \\ 1086 \\ 1540 \\ 1448 \\ 920 \\ 905 \\ 15/181 \text{ remainder} \end{array}$$

Rounded to two decimal places--Output shaft speed = 2596.69 RPM

## CONSTANT MESH OPERATION
## UNIT II

NAME ____________________________

## TEST

1. Define gear ratio.

2. Distinguish between the two gear shift patterns by placing an "X" next to the description of the standardized pattern.

   ______a. 1st gear down from neutral and 2nd, 3rd, 4th, and 5th gears up from neutral

   ______b. 1st gear up from neutral and 2nd, 3rd, and 4th gears down from neutral

3. Match the types of shifter mechanisms on the right to the correct operations.

   ______a. Shift forks follow slots cut in camplate

   ______b. Pawl contacts drum pin causing drum to rotate

   ______c. Steel balls engage slots in inner surfaces of gears

   ______d. Camplate moves shifter rod in or out of hollow countershaft

   ______e. Forks move sideways because pins in forks must follow grooves in drum

   ______f. Camplate and shift rod do not return to a central position for the next shift

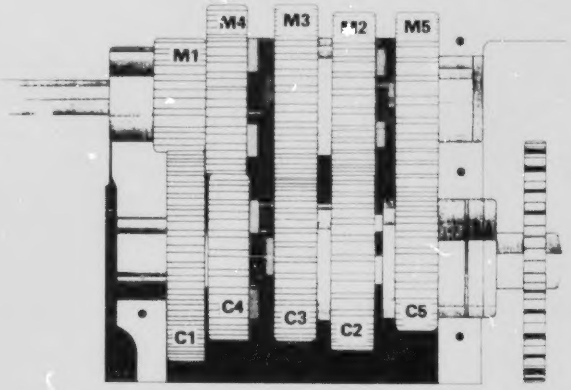
   ______g. Quadrant pivots to rotate camplate

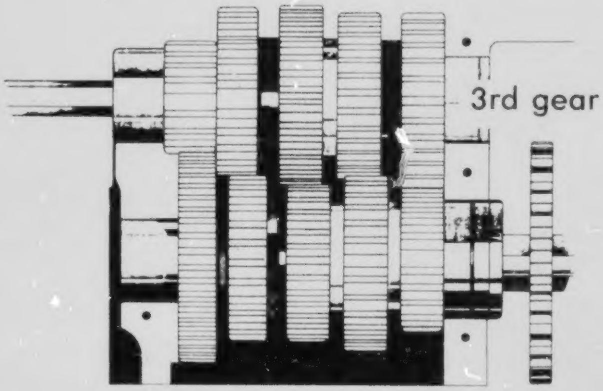
   ______h. Index plunger holds camplate and quadrant in position between shifts

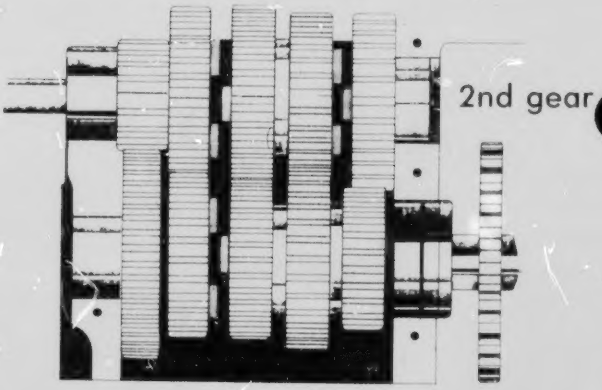
   1. Drum
   2. Camplate and shift quadrant
   3. Ball lock

4. Trace the power flow through the transmission in the gear combinations by writing the correct sequence in the space below each illustration.

Use this illustration for gear numbering reference.

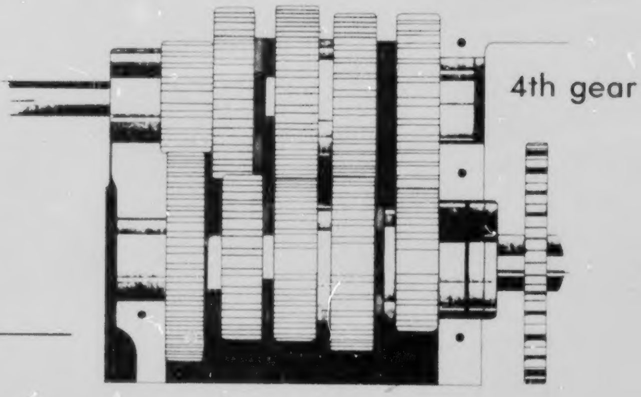

M4
M3
M2
M5
M1
C4
C3
C5
C1
C2





a. ______________________________

b. ______________________________



c. ______________________________

5 Calculate gear ratios.

a. If the mainshaft gear has 16 teeth and the corresponding countershaft gear has 45 teeth, what is the gear ratio? Round ratio to two decimal places.

b. Brand Z motorcycle has a 5 speed transmission with 22 teeth on the 4th speed mainshaft gear and 28 teeth on the countershaft gear. What is the gear ratio for 4th gear? Round ratio to two decimal places.

c. A given 4-speed transmission has 21 teeth on the M-2 gear and 38 teeth on the C-2 gear. If the output shaft speed is measured at 2740 RPM, what is the input shaft speed? Round ratio to two decimal places.

## CONSTANT MESH OPERATION
## UNIT II

### ANSWERS TO TEST

1. Gear ratio--Number of teeth on countershaft gear in relation to the number of teeth on mainshaft gear

2. a

3.
   a. 2

   b. 1

   c. 3

   d. 3

   e. 1

   f. 3

   g. 2

   h. 2

4.
   a. Power flow is mainshaft to M-2 and 3 to C-3 to C-4 to countershaft

   b. Power flow is mainshaft to M-2 and 3 to C-2 to C-5 to countershaft

   c. Power flow is mainshaft to M-2 and 3 to M-4 to C-4 to countershaft

5.
   a. 45:16 = $\frac{45}{16}$ : $\frac{16}{16}$

```
        2.812                 1
16  | 45.000       :     16  16
      32                     16
      130
      128
        20
        16
          40
          32
           8/16 remainder
```

Rounded to two decimal places--Ratio is 2.81:1

b. 28:22 $= \frac{28}{22} : \frac{22}{22}$

```
       1.272                 1
22 |28.000        :    22 | 22
    22                      22
     60
     44
     160
     154
       60
       44
       16/22 remainder
```

Rounded to two decimal places--Ratio is 1.27:1

c. 38:21 $= \frac{38}{21} : \frac{21}{21}$

```
        1.809                1
21   |38.000      :    21 | 21
       21                   21
       170
       168
         20
          0
        200
        189
          11/21 remainder
```

Rounded to two decimal places--Ratio is 1.81:1

```
2740 x 1.81    =      2740
                    x 1.81
                      2740
                    21920
                    2740
                   4959.40
```

Input shaft speed is 4959.4 RPM

# CONSTANT MESH SERVICE
# UNIT III

## UNIT OBJECTIVE

After completion of this unit, the student should be able to select possible causes of transmission malfunctions and match types of wear and damage to constant mesh transmission parts. The student should also be able to identify crankcase designs and disassemble, inspect, reassemble, and adjust a constant mesh transmission. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Select the possible causes of specific transmission malfunctions.
2. Match types of wear and damage to the correct affected constant mesh transmission parts.
3. Identify the transmission crankcase designs.
4. Demonstrate the ability to:
    a. Remove and disassemble a constant mesh transmission.
    b. Inspect, reassemble, and install a constant mesh transmission and adjust, if necessary.

# CONSTANT MESH SERVICE
# UNIT III

## SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss the procedures outlined in the job sheets.

   G. Gather an assortment of used, worn transmission parts for the student to inspect, measure, and compare.

   H. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheets.

   D. Complete activities assigned by instructor.

   E. Take test.

## INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Worn and Damaged Parts - Gears

      2. TM 2--Worn and Damaged Parts - Shifter Mechanism

3. TM 3--Worn and Damaged Parts - Shafts
4. TM 4--Crankcase Designs

D. Job sheets

1. Job Sheet #1--Remove and Disassemble a Constant Mesh Transmission
2. Job Sheet #2--Inspect, Reassemble, and Install a Constant Mesh Transmission and Adjust, if Necessary

E. Test

F. Answers to test

II. References:

A. *Motorcycle Systems Training Manual-Motorcycle Power Train.* Kawasaki Motors Corp., 1973.

B. *Honda 450 Service Manual-Models CB 450, CL 450.* Honda Motor Co., Ltd., 1971.

C. *Honda 250-350 Service Manual.* Honda Motor Co., Ltd., 1972.

D. Glenn, Harold T. *Glenn's Honda Two-Cylinder Repair and Tune-Up Guide.* New York: Crown Publishers, Inc., 1972.

E. Forsdyke, Graham. *Motorcycle Maintenance Illustrated.* Parkhurst Publishing Co., 1967.

F. *Chilton's New Motorcycle Troubleshooting Guide.* Radnor, Pennsylvania: Chilton Book Co., 1973.

# CONSTANT MESH SERVICE
# UNIT III

## INFORMATION SHEET

I. Transmission malfunctions and possible causes

- A. Gears grind when shifting
    1. Clutch not releasing completely
    2. Worn shifter mechanism
    3. Worn sliding dog gears
    4. Worn thrust washers
    5. Worn transmission shafts
- B. Transmission jumps out of gear
    1. Sliding dog gears not fully engaging due to worn parts
    2. Improper adjustment (where required)
    3. Insufficient detent spring tension
    4. Worn detent
    5. Damaged shift linkage
- C. Transmission shifts hard
    1. Clutch not releasing completely
    2. Worn, damaged, or misadjusted shifter mechanism
    3. Transmission lubricant level low
    4. Improper shaft alignment
    5. Scored or damaged shaft splines
    6. Binding shift drum or camplates
- D. Transmission will not shift
    1. Broken or incorrectly installed shift linkage
    2. Shift pedal loose on shift shaft

## INFORMATION SHEET

        3. Sliding dog gears binding on shaft
        4. Seized shift drum or camplate
        5. Broken shift forks

    E. Excessive transmission noise
        1. Gears with broken teeth
        2. Worn transmission shaft bearings
        3. Transmission very low on lubricant
        4. Excessive gear backlash
        5. Mating a new gear to a worn gear

II. Wear and damage on constant mesh transmission parts (Transparencies 1, 2, and 3)

    A. Gears
        1. Dogs
            a. Worn
            b. Chipped
            c. Broken
        2. Gear teeth chipped
        3. Shift fork grooves worn

    B. Shifter mechanism
        1. Forks worn or broken
        2. Drum diameter worn
        3. Camplate contours worn
        4. Detents worn
        5. Shift linkage worn
        6. Detent springs weak

## INFORMATION SHEET

C. Shafts

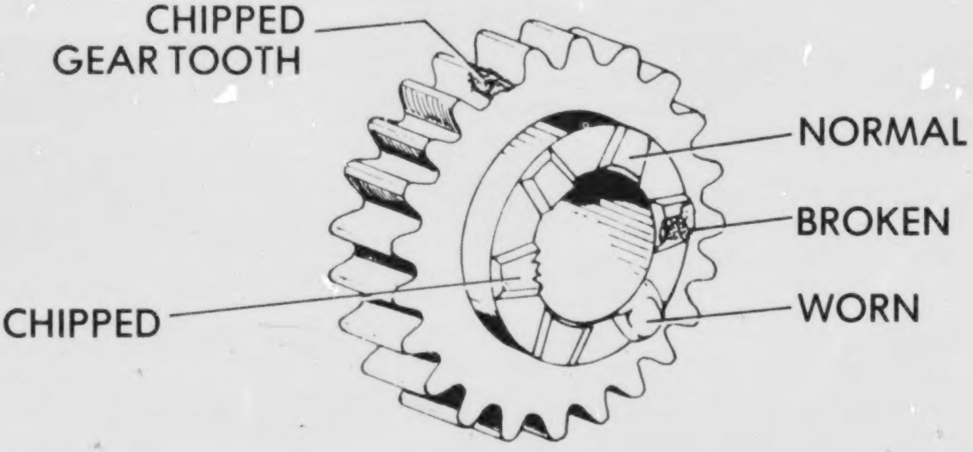
1. Splines worn
2. Splines damaged or scored
3. Bearings damaged
4. Worn snap rings or thrust washers

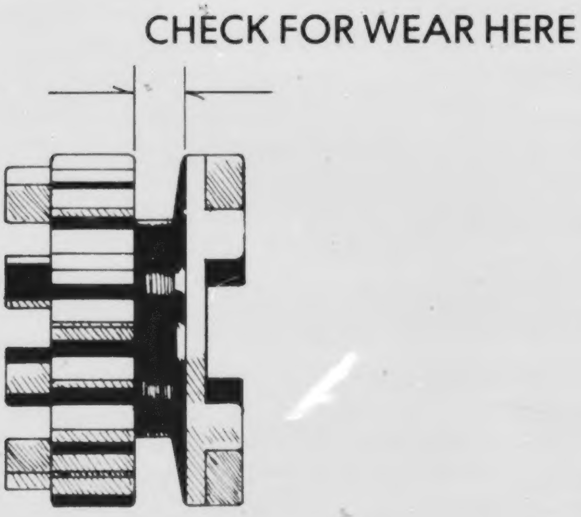
III. Transmission crankcase designs (Transparency 4)

A. Horizontal split

B. Vertical split

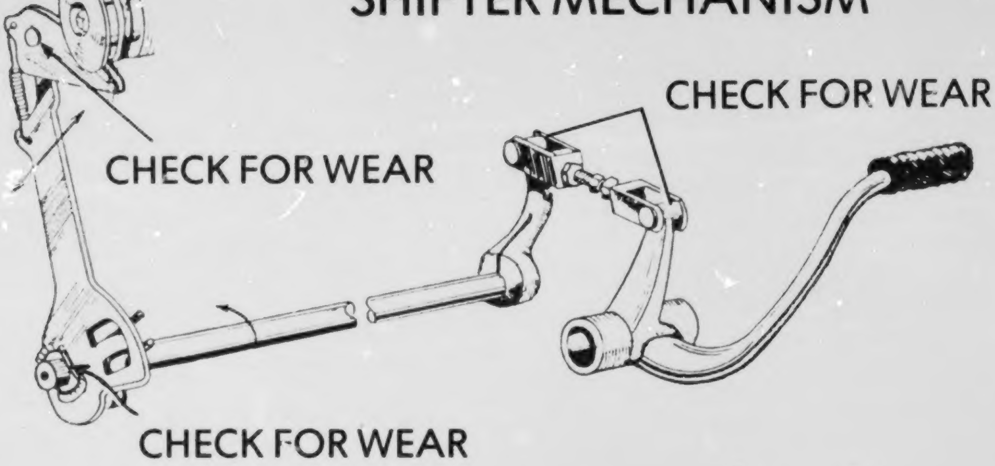
# WORN AND DAMAGED PARTS
## GEARS

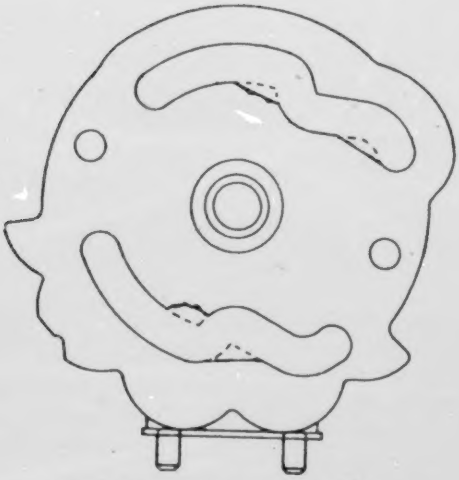

CHIPPED GEAR TOOTH
NORMAL
BROKEN
CHIPPED
WORN


CHECK FOR WEAR HERE

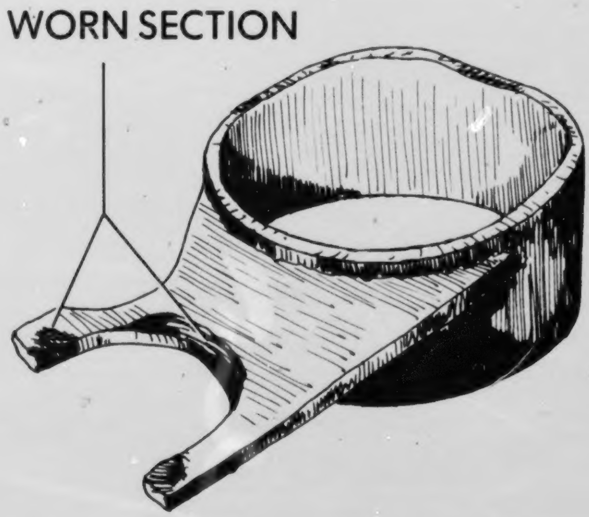
SLIDER

# WORN AND DAMAGED PARTS SHIFTER MECHANISM


CHECK FOR WEAR
CHECK FOR WEAR
CHECK FOR WEAR

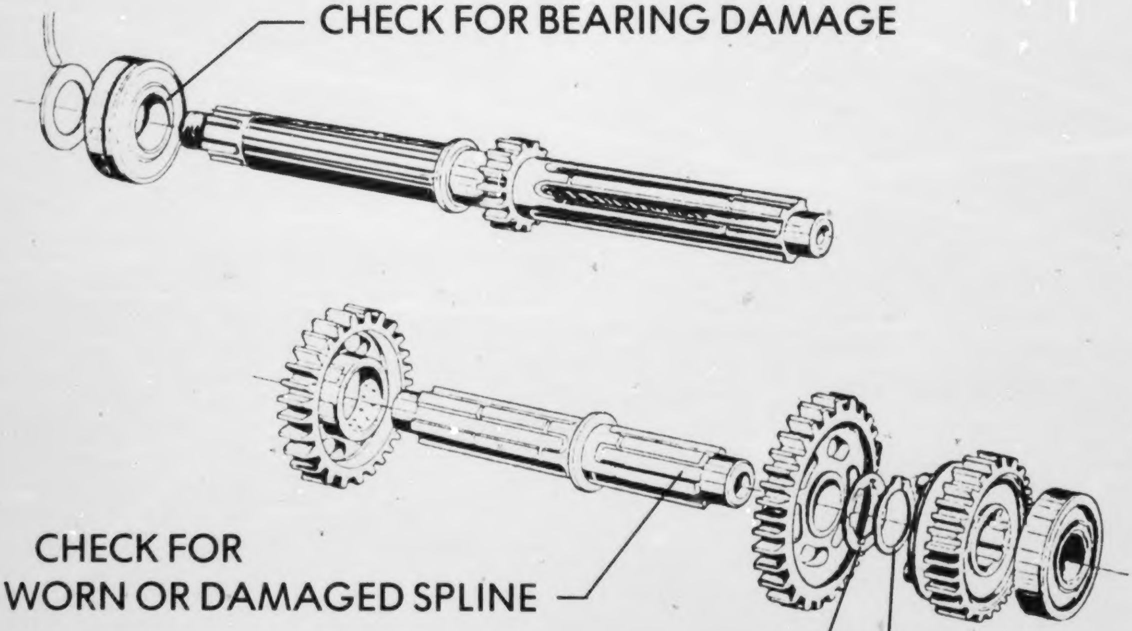


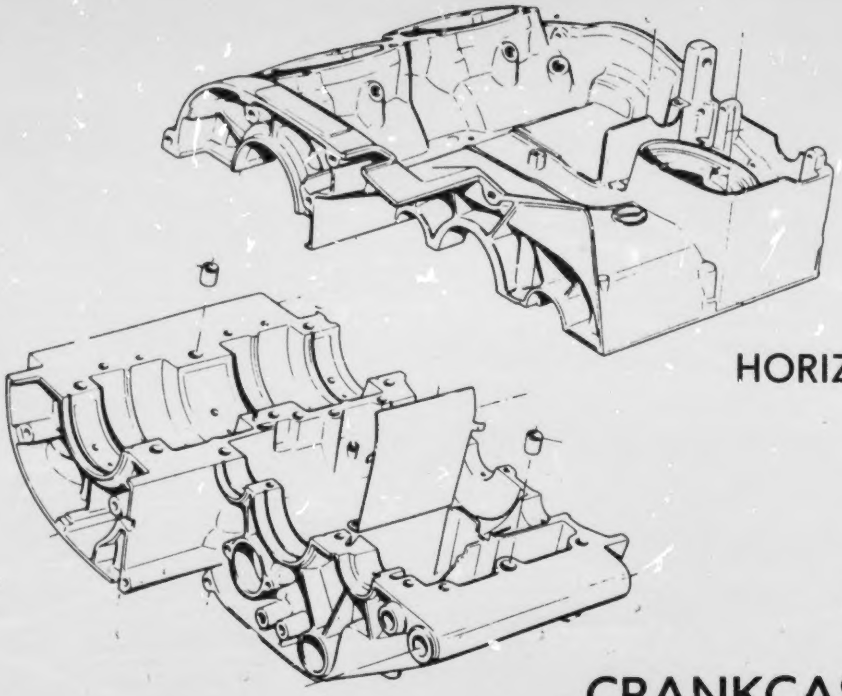
WORN CONTOURS


WORN SECTION

CHECK WEAR WITH A CALIPER

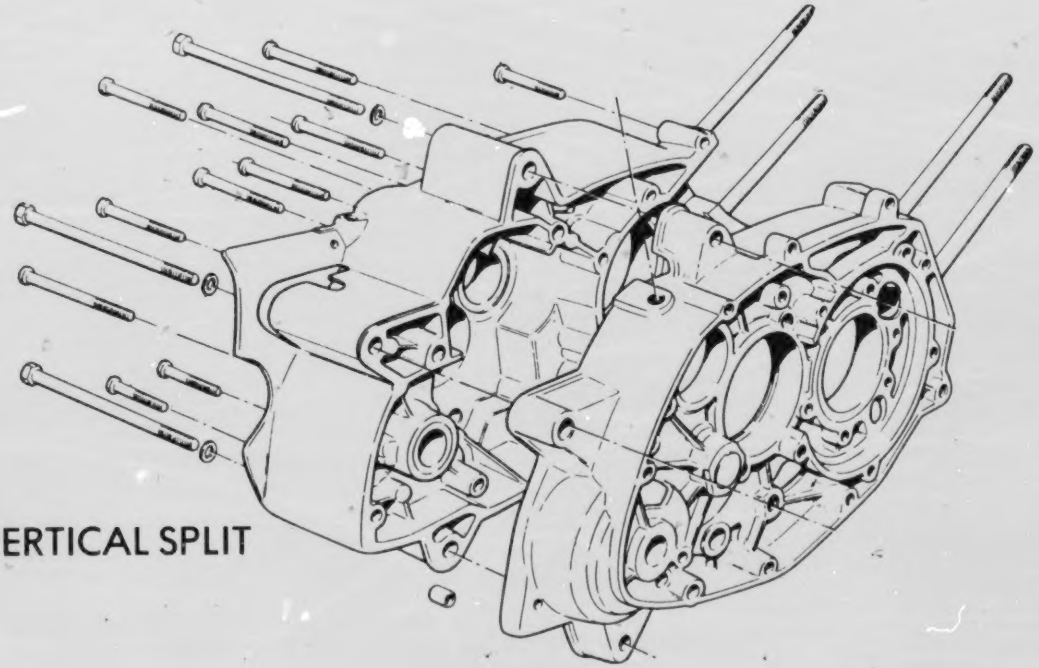
# WORN AND DAMAGED PARTS
## SHAFTS


CHECK FOR BEARING DAMAGE
CHECK FOR
WORN OR DAMAGED SPLINE
CHECK FOR WORN THRUST WASHER
CHECK FOR WORN SNAP RING



HORIZONTAL SPLIT

# CRANKCASE DESIGNS



VERTICAL SPLIT

# CONSTANT MESH SERVICE
# UNIT III

## JOB SHEET #1--REMOVE AND DISASSEMBLE A CONSTANT MESH TRANSMISSION

I. Tools and materials

   A. Hand tool assortment

   B. 3/8" drive phillips screwdriver socket

   C. Snap ring pliers

   D. Dial indicator and mounting stand

   E. Case divider tool

   F. Drain pan

   G. Shop towels

   H. Appropriate service manual

   I. Impact driver

   J. Soft face hammer

   K. Safety glasses

II. Procedure

   A. Place drain pan under vehicle and drain lubricant from transmission

   (NOTE: Four stroke vehicles use a common crankcase and transmission lubricant.)

   B. Inspect lubricant and magnetic drain plug, if one is used, for metal chips and shavings which would indicate worn or damaged parts

   C. Consult the service manual while transmission is draining, and proceed with the following:

      1. Remove fuel tank

      (NOTE: Be certain fuel valve is in the off position before disconnecting fuel lines.)

      2. Disconnect control cables

## JOB SHEET #1

   3. Remove exhaust system

   4. Disconnect necessary electrical wiring

   5. Separate drive chain and remove

   6. Loosen engine mounting bolts

      (CAUTION: Do not remove these bolts until you are prepared to lift engine out of chassis.)

D. Replace drain plug in bottom of crankcase

E. Remove drain pan from under vehicle

F. Remove engine mounting bolts and lift engine from chassis

   (NOTE: It may be necessary to enlist the aid of another person in lifting engine from chassis.)

G. Disassemble transmission crankcase

   1. Horizontal split design

      (NOTE: Consult the service manual for the exact procedure for disassembly of specific transmissions.)

      a. Remove kickstart pedal and shift lever

      b. Remove engine side covers

      c. Remove kickstart mechanism

      d. Remove clutch

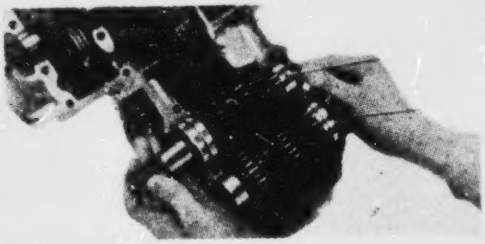
      e. Remove bolts holding upper and lower case halves together

## JOB SHEET #1

f. Separate and remove lower case half, with gears and shafts, from engine (Figure 1)

(CAUTION: Care should be exercised in separating case halves so as not to damage cases.)

FIGURE 1



g. Measure gear backlash with dial indicator before removing gears and shafts from case (Figure 2)

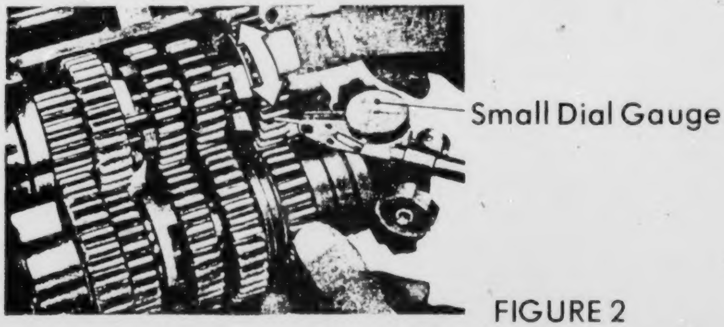


FIGURE 2

2. Vertical split design
   a. Remove kickstart pedal and shift lever
   b. Remove engine side covers
   c. Remove kickstart mechanism
   d. Remove clutch
   e. Remove cylinder head or heads
   f. Remove cylinder or cylinders

## JOB SHEET #1

g. Remove bolts holding case halves together

h. Separate case halves

(CAUTION: Care should be exercised in separating case halves so as not to damage cases.)

1) Install case divider tool (Figure 3)

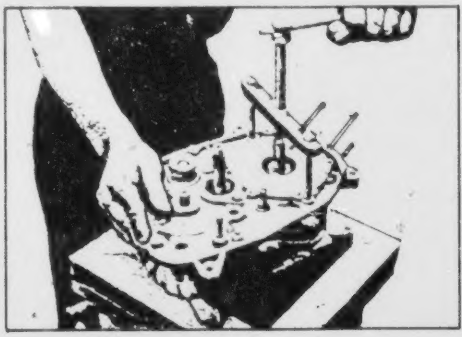


FIGURE 3

2) Tap the transmission mainshaft with soft face hammer (Figure 4)

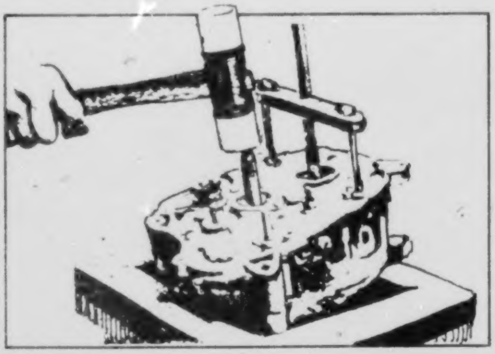


FIGURE 4

H. Remove gear and shaft assemblies

I. Remove shifter mechanism

J. Remove gears from their respective shafts by removing snap rings and thrust washers

(NOTE: Be sure to keep snap rings and thrust washers in proper order.)

K. Clean parts in preparation for inspection

## CONSTANT MESH SERVICE
## UNIT III

### JOB SHEET #2--INSPECT, REASSEMBLE, AND INSTALL A CONSTANT MESH TRANSMISSION AND ADJUST, IF NECESSARY

I. Tools and materials

   A. Hand tool assortment

   B. 3/8" drive phillips screwdriver socket

   C. Snap ring pliers

   D. Feeler gauge pack

   E. Shop towels

   F. Appropriate service manual

   G. Appropriate transmission lubricant

   H. Safety glasses

II. Procedure

   A. Inspect gear teeth for wear and chipping (Figure 1)

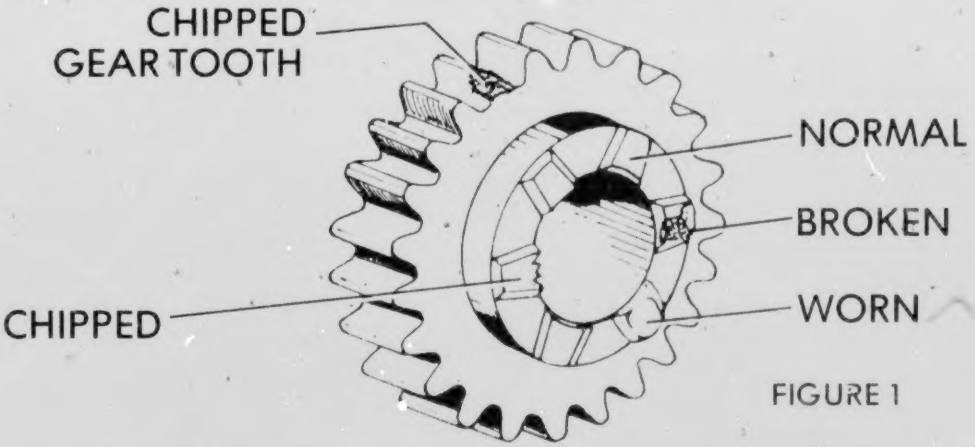


FIGURE 1

   B. Inspect sliding dog gears for wear at the dogs (Figure 1)

   C. Inspect sliding gears for wear in the shift fork grooves

## JOB SHEET #2

D. Measure thickness of shift forks to determine wear (Figure 2)

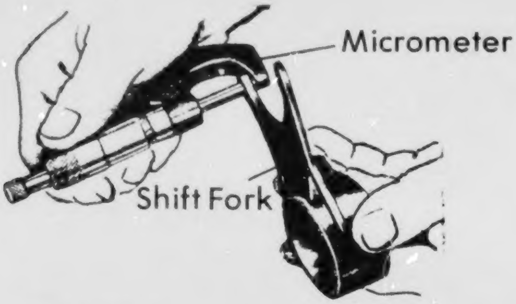
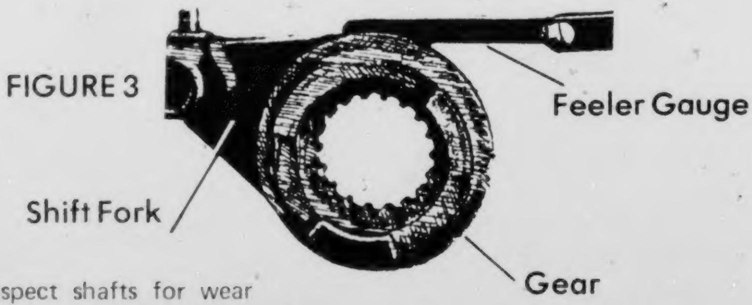

Micrometer
Shift Fork

FIGURE 2

E. Measure clearance between shift fork and gear groove (Figure 3)

FIGURE 3


Feeler Gauge
Shift Fork
Gear

F. Inspect shafts for wear

G. Inspect thrust washers for wear

H. Inspect and measure shift drum for wear and damage (Figure 4)

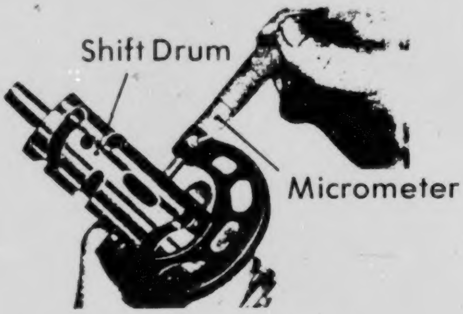

Shift Drum
Micrometer

FIGURE 4

I. Check bearings for wear and smooth running

## JOB SHEET #2

J. Assemble gears, thrust washers, and snap rings on their shafts; consult service manual for the correct order

(NOTE: The following points should be kept in mind when assembling gears and shafts:

1. The shafts must remain parallel when the gears are installed
2. First gear drive is usually cut into the shaft itself; no other gear is
3. Splined or fixed gears always mesh with free spinning gears
4. Round dogs against round holes; square dogs against square dogs
5. Double sliding gears need two free spinning gears on the other shaft
6. Sliding gears or fixed gears alternate with free spinning gears, except when this conflicts with previous rules.)

K. Assemble shifter mechanism as instructed in service manual

L. Install shifter mechanism in transmission case

M. Install gear and shaft assemblies

N. Assemble case halves according to manufacturer's recommendations

O. Install clutch

P. Install kickstart mechanism

Q. Adjust shift stopper plate, if applicable

R. Install side covers

S. Install kickstart pedal and shift lever

T. Position engine in chassis

U. Align mounting holes and install engine mounting bolts

V. Install drive chain

## JOB SHEET #2

W. Connect electrical wiring

X. Install exhaust system

Y. Connect control cables

Z. Replace fuel tank and connect fuel lines

AA. Fill transmission and/or crankcase with the proper lubricant

# CONSTANT MESH SERVICE
## UNIT III

NAME ______________________

## TEST

1. Select the possible causes of specific transmission malfunctions by placing an "X" in the appropriate blanks.

   a. Gears grind when shifting

   _____1) Insufficient detent spring tension

   _____2) Worn shifter mechanism

   _____3) Sliding dog gears binding on shaft

   _____4) Clutch not releasing completely

   b. Transmission jumps out of gear

   _____1) Worn detent

   _____2) Shift pedal loose on shaft

   _____3) Excessive gear backlash

   _____4) Sliding dog gears not fully engaging due to worn parts

   c. Transmission shifts hard

   _____1) Broken shift forks

   _____2) Transmission lubricant level low

   _____3) Worn sliding dog gears

   _____4) Improper shaft alignment

   d. Transmission will not shift

   _____1) Damaged shift linkage

   _____2) Scored or damaged shaft splines

   _____3) Seized shift drum or camplate

   _____4) Shift pedal loose on shift shaft

e. Excessive transmission noise

_____1) Transmission very low on lubricant

_____2) Gears with broken teeth

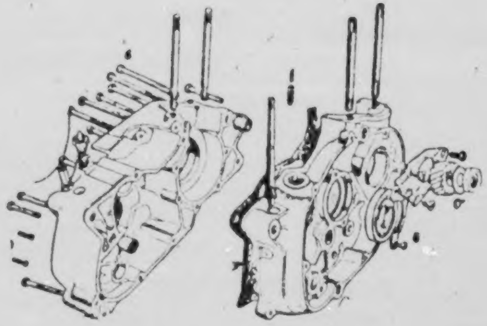
_____3) Worn, damaged, or misadjusted shifter mechanism

_____4) Worn thrust washers

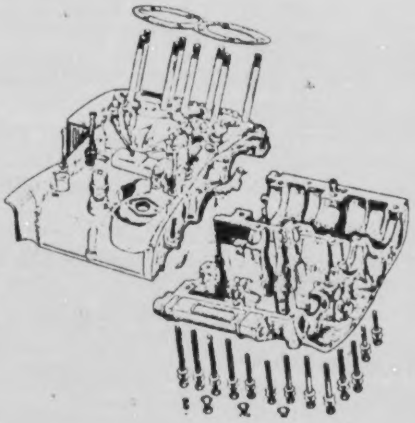
2. Match types of wear and damage on the right to the correct affected constant mesh transmission parts.

| | | | |
|---|---|---|---|
| _____a. Gears | | 1. | Splines damaged or scored |
| _____b. Shifter mechanism | | 2. | Shift fork grooves worn |
| _____c. Shafts | | 3. | Detents worn |

3. Identify the transmission crankcase designs.



a. ____________ ____________



b. ____________ ____________

4. Demonstrate the ability to:

a. Remove and disassemble a constant mesh transmission.

b. Inspect, reassemble, and install a constant mesh transmission and adjust, if necessary.

(NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

# CONSTANT MESH SERVICE
## UNIT III

## ANSWERS TO TEST

1. a. 2, 4
   b. 1, 4
   c. 2, 4
   d. 3, 4
   e. 1, 2
2. a. 2
   b. 3
   c. 1
3. a. Vertical split
   b. Horizontal split
4. Performance skills evaluated to the satisfaction of the instructor

# CHAIN AND SPROCKET FINAL DRIVES
## UNIT I

## UNIT OBJECTIVE

After completion of this unit, the student should be able to identify the components of the chain and sprocket final drive and list the purposes of a rear hub damper. The student should also be able to describe the construction and sizing of a roller type chain, select the causes of premature chain and sprocket wear, and perform all inspections, adjustments, and maintenance services on final drives. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with chain and sprocket final drives to the correct definitions.
2. Identify the components of a chain and sprocket final drive.
3. List the purposes of a rear hub damper.
4. Describe the construction and sizing of a roller type chain.
5. Select the causes of premature chain and sprocket wear.
6. Demonstrate the ability to:
    a. Inspect and measure chain and sprockets.
    b. Adjust chain tension and alignment.
    c. Clean and lubricate chain.
    d. Check wheel tracking alignment.

# CHAIN AND SPROCKET FINAL DRIVES
## UNIT I

## SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss the procedures outlined in the job sheets.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheets.

   D. Take test.

## INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Chain and Sprocket Final Drive Components

      2. TM 2--Roller Type Chain

      3. TM 3--Chain and Sprocket Wear

D. Job sheets

   1. Job Sheet #1--Inspect and Measure Chain and Sprockets
   2. Job Sheet #2--Adjust Chain Tension and Alignment
   3. Job Sheet #3--Clean and Lubricate Chain
   4. Job Sheet #4--Check Wheel Tracking Alignment

E. Test

F. Answers to test

II. References:

A. *Harley-Davidson Service Manual, Electra Glide 1959-1969.* Milwaukee, Wisconsin: Harley-Davidson Motor Co., 1971.

B. Forsdyke, Graham. *Motorcycle Maintenance Illustrated.* Parkhurst Publishing Co., 1967.

C. *Chilton's New Motorcycle Troubleshooting Guide.* Radnor, Pennsylvania: Chilton Book Co., 1973.

D. *Motorcycle Service Manual.* Vol. 1. 3rd ed. Kansas City, Missouri: Technical Publications Division/Intertec Publishing Corp., 1972.

E. *Honda 90 Service Manual.* Honda Motor Co., Ltd., 1970.

F. *Suzuki GT550 Service Manual.* Suzuki Motor Co., Ltd., 1973.

G. *Yamaha Service Manual YL2-YL2C.* Yamaha Motor Co., Ltd.

H. *Motorcycle Systems Training Manual-Motorcycle Power Train.* Kawasaki Motors Corp., 1973.

# CHAIN AND SPROCKET FINAL DRIVES
## UNIT I

## INFORMATION SHEET

I. Terms and definitions

  A. Chain pitch--Center to center distance between the pins of the chain

  B. Chain width--Width between the inner side plates

  C. Chain diameter--Thickness of the chain rollers

  D. Chain stretch--Lengthening of the chain due to wear between the roller and bushing, and the bushing and pin

  E. Chain case--Case that protects chain from excessive dirt and water

  (NOTE: The chain case prolonges the life of the chain and sprocket.)

II. Components of chain and sprocket final drive (Transparency 1)

  A. Drive sprocket

  B. Drive chain with master link

  C. Driven or rear wheel sprocket

  D. Final drive flange or rear sprocket drum

  E. Rear hub damper

  F. Chain adjuster

  G. Chain case

  H. Chain oiler

  (NOTE: Not all motorcycles have a chain case or a chain oiler.)

III. Purposes of a rear hub damper

  A. Absorbs some of the shock of the final drive when the clutch is engaged and engine torque reaches rear wheel

  B. Provides some degree of protection for the drive train

## INFORMATION SHEET

IV. Construction and sizing of roller type chain (Tranparency 2)

  A. Construction

    1. Inner and outer plates, held together by steel pins, form links

    2. Pins attached to outer plates

    3. Bushings attached to inner plates

    4. Pins assembled through inside of bushings

    5. Rollers fit around outside of bushings

    (NOTE: Rollers roll around pins to form a bearing between pin and sprocket teeth.)

  B. Sizing determined by:

    1. Pitch

    2. Width

    3. Roller diameter

  (NOTE: Chain and sprockets must be matched.)

V. Causes of premature chain and sprocket wear (Transparency 3)

  A. Operating in excessively dirty conditions

  B. Improper tension

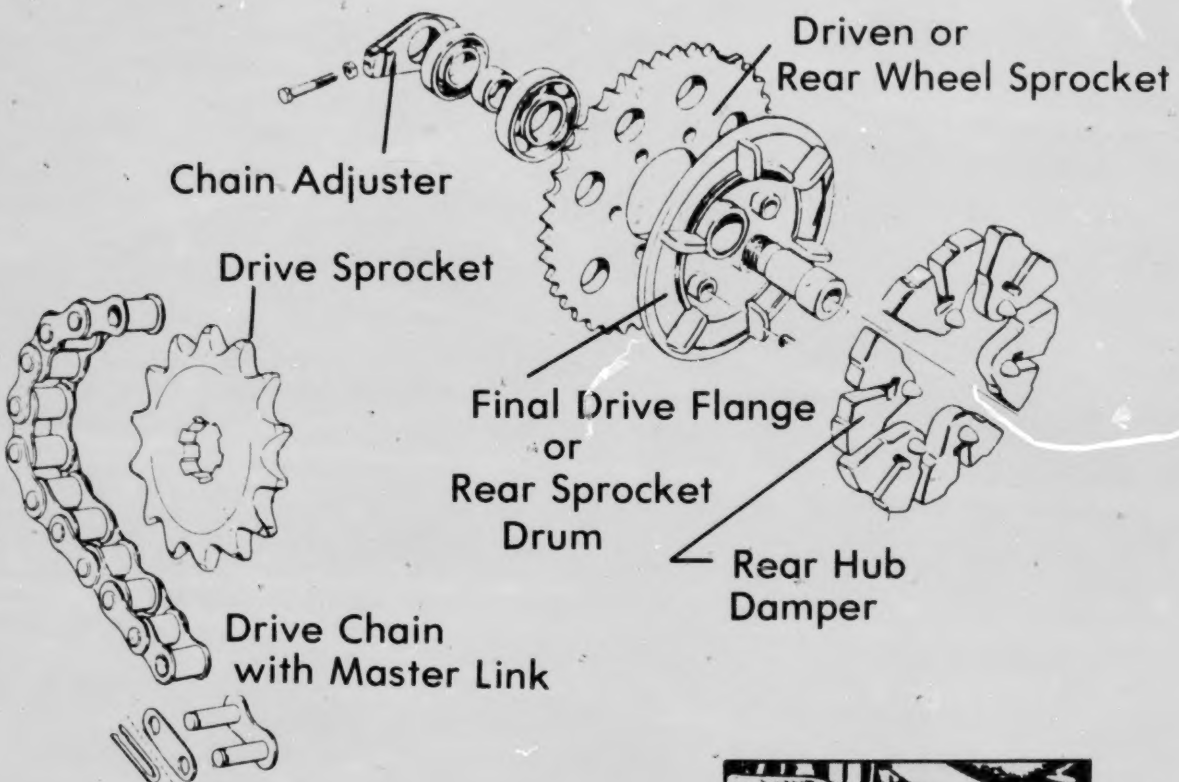
  C. Improper alignment

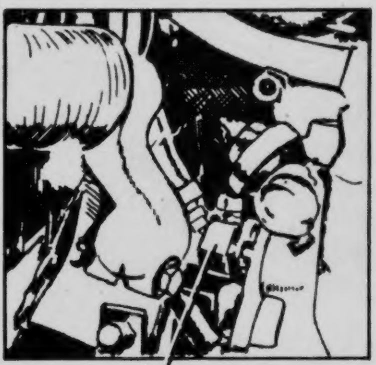
  D. Poor lubrication

  E. Failure to clean properly

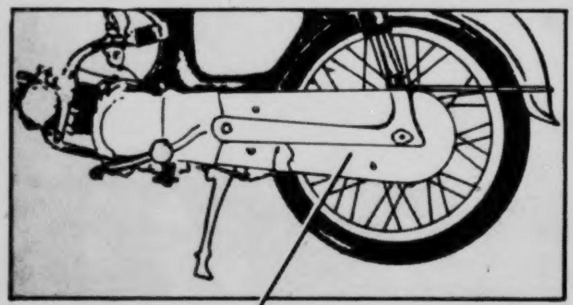
  (NOTE: Wear in the chain is shown between side plates and between pin, bushing, and roller; wear in sprocket is shown in the teeth.)

# CHAIN AND SPROCKET FINAL DRIVE COMPONENTS

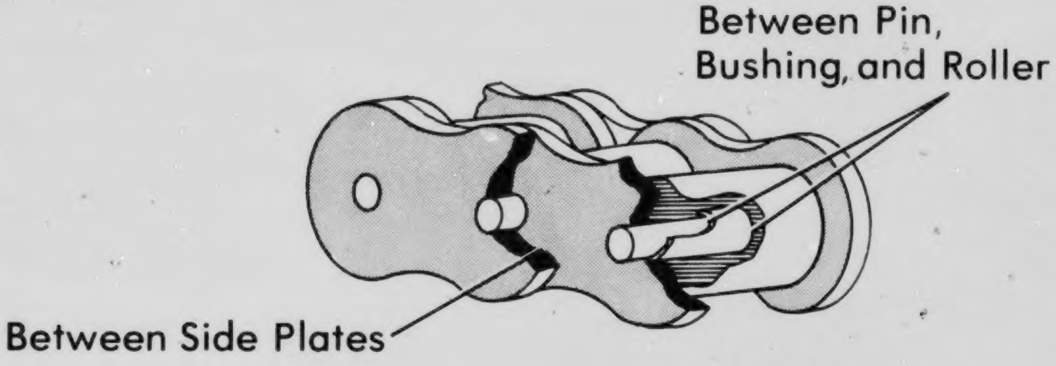

Driven or
Rear Wheel Sprocket
Chain Adjuster
Drive Sprocket
Final Drive Flange
or
Rear Sprocket
Drum
Rear Hub
Damper
Drive Chain
with Master Link



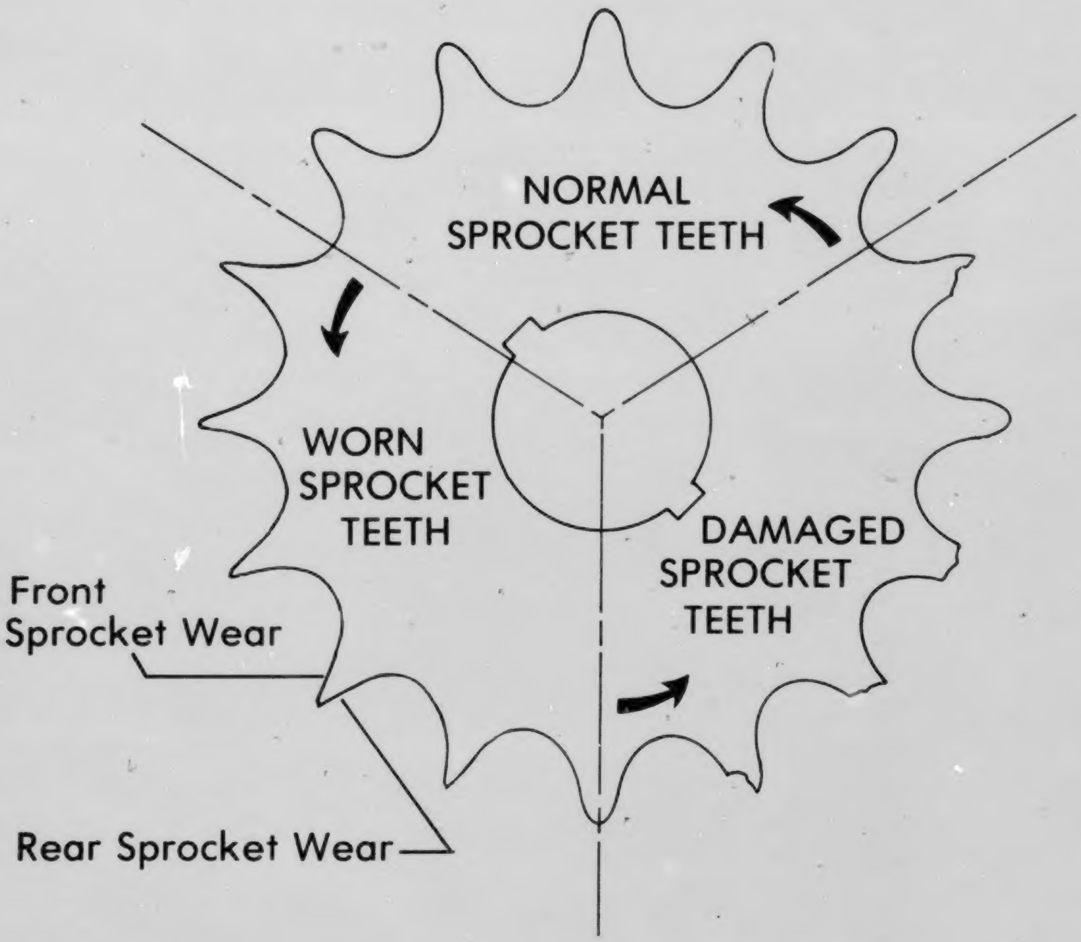
Chain Oiler



Chain Case


Between Pin,
Bushing, and Roller
Between Side Plates

# CHAIN AND SPROCKET WEAR


NORMAL
SPROCKET TEETH
WORN
SPROCKET
TEETH
DAMAGED
SPROCKET
TEETH
Front
Sprocket Wear
Rear Sprocket Wear

# CHAIN AND SPROCKET FINAL DRIVES
## UNIT I

## JOB SHEET #1--INSPECT AND MEASURE CHAIN AND SPROCKETS

I. Tools and materials

A. Motorcycle with chain and sprockets installed

B. Assortment of used chains

C. Assortment of used sprockets

D. Tape measure or other device suitable for measuring chain stretch

E. Safety glasses

II. Procedure

A. Pull on the chain at the rear sprocket (Figure 1)

(NOTE: If the chain can be pulled more than 1/4 inch off the rear sprocket, there is too much wear.)

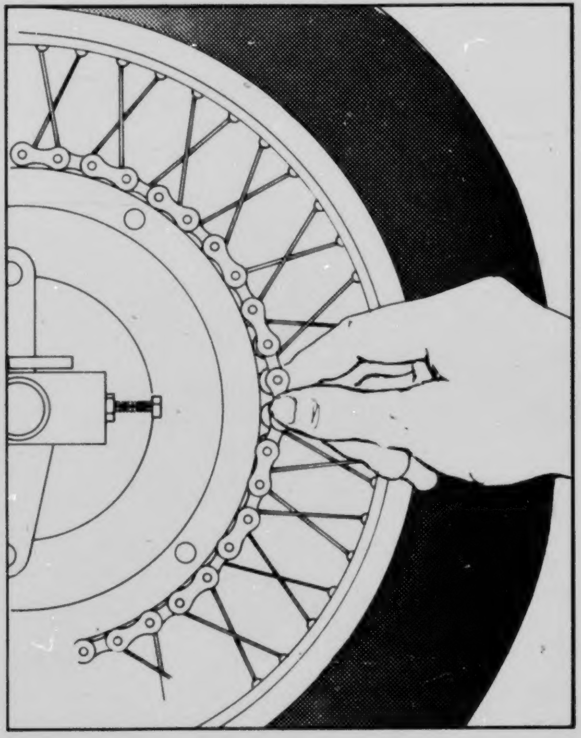
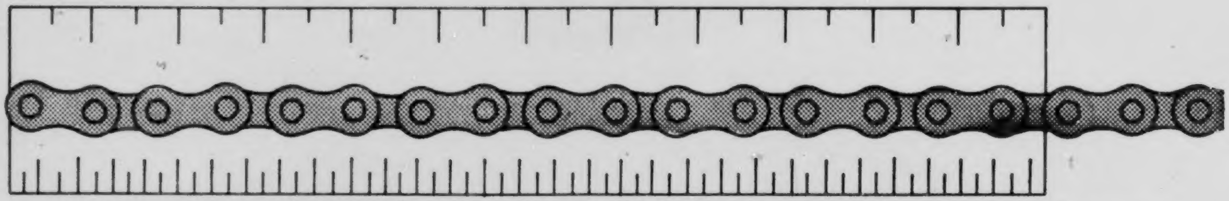


FIGURE 1

JOB SHEET #1

B. Lay the chain on a flat surface; stretch it to its full length and measure it (Figure 2)

**FIGURE 2**



CHAIN STRETCH SHOULD NOT EXCEED ¼" PER FOOT (6.5 cm PER 305 cm.)

C. Compress the chain as short as possible without bending or kinking the chain and measure it

D. Subtract the shortened length from the stretched length

(NOTE: The difference is the amount of stretch, and it should not exceed 1/4 inch per foot.)

Example: A 4 foot chain should not have a stretch of more than 1 inch in length

E. Inspect the chain for:

1. Damaged rollers
2. Loose pins
3. Dry or rusted links
4. Kinked or bent links
5. Bound links

F. Inspect the sprockets for:

1. Excessive tooth wear
2. Excessive spline wear (front sprocket)
3. Side wear on sprocket teeth

   (NOTE: This indicates a chain alignment problem.)
4. Broken or damaged teeth

# CHAIN AND SPROCKET FINAL DRIVES
## UNIT I

## JOB SHEET #2--ADJUST CHAIN TENSION AND ALIGNMENT

I. Tools and materials

   A. Motorcycle with all final drive components installed

   B. Metric wrench set

   C. Hand tool assortment

   D. Appropriate service manual

   E. Safety glasses

II. Procedure

   (NOTE: Chain should be adjusted with a weight equal to that of the operator on cycle.)

   A. Loosen rear axle nut, adjusting bolt locknuts, and adjusting bolts (Figure 1)

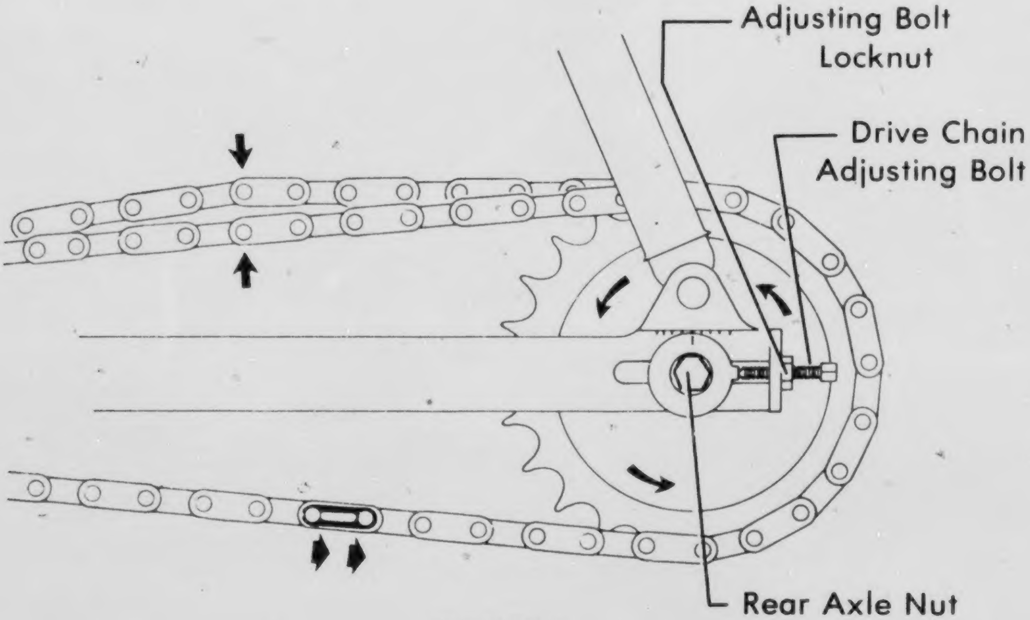

Adjusting Bolt Locknut
Drive Chain Adjusting Bolt
Rear Axle Nut

FIGURE 1

## JOB SHEET #2

B. Turn both adjusting bolts in or out until proper free play or chain slack is obtained (Figure 2)

(NOTE: The rule of thumb is 1/2-3/4 inch of slack midway between the two sprockets.)

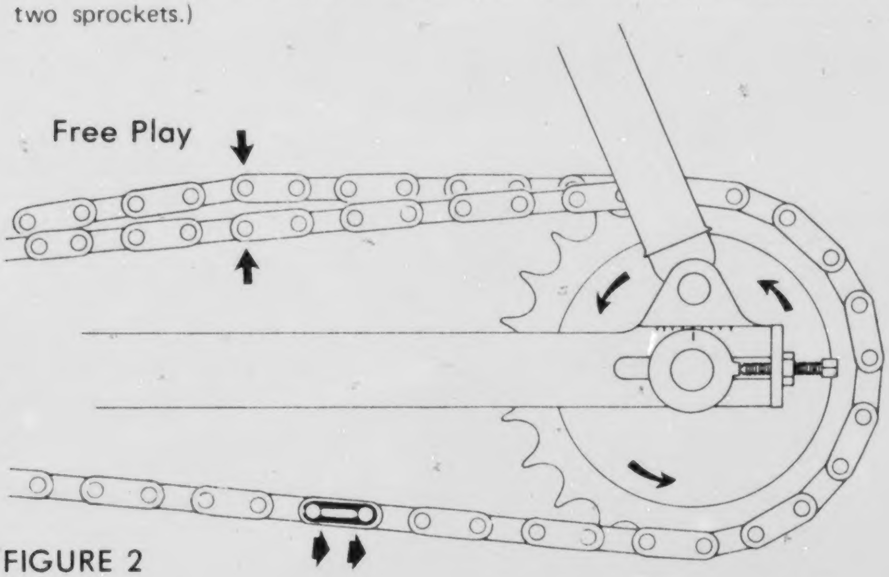


FIGURE 2

C. Turn both adjusting bolts an equal amount to maintain correct alignment; if reference marks are present, be sure the same marks are in alignment on both sides of the wheel (Figure 3)

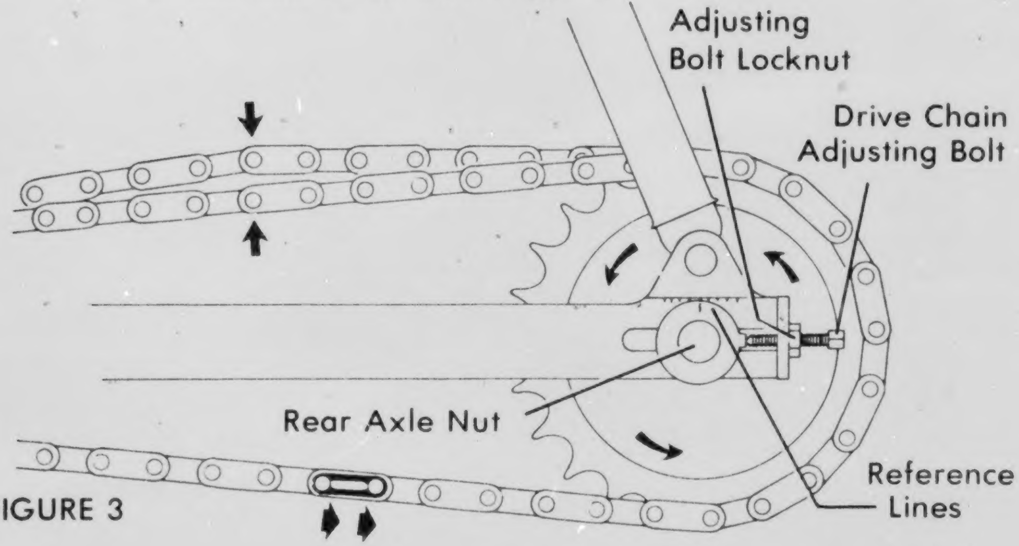

Adjusting
Bolt Locknut
Drive Chain
Adjusting Bolt
Rear Axle Nut
Reference
Lines

FIGURE 3

JOB SHEET #2

D. Tighten axle nut, adjusting bolt locknuts, and adjusting bolts

E. Recheck chain adjustment and alignment (Figure 4)

(NOTE: Since moving the rear wheel changes the distance between the brake pedal and the wheel, it may also be necessary to adjust the rear brake.)

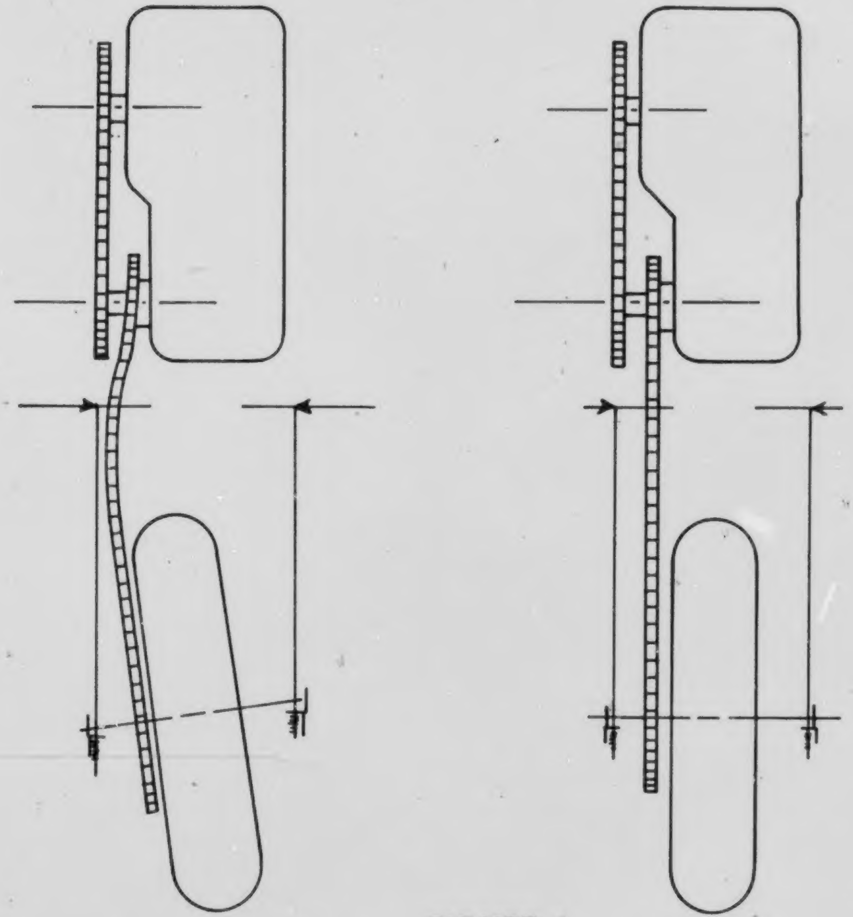


FIGURE 4

# CHAIN AND SPROCKET FINAL DRIVES
## UNIT I

## JOB SHEET #3--CLEAN AND LUBRICATE CHAIN

I. Tools and materials

- A. Cleaning pan
- B. Cleaning solvent

  (CAUTION: Do not use gasoline.)
- C. Cleaning brush
- D. Grease pan
- E. Commercial chain grease
- F. Hot plate or other method for heating grease
- G. Safety glasses

II. Procedure

- A. Soak and wash chain thoroughly in a pan of cleaning solvent
- B. Remove chain from solvent and hang so solvent will drain off
- C. Immerse chain in a pan of chain grease heated to consistency of light engine oil
- D. While immersed, move chain around to be sure hot grease works through all inside parts (Figure 1)

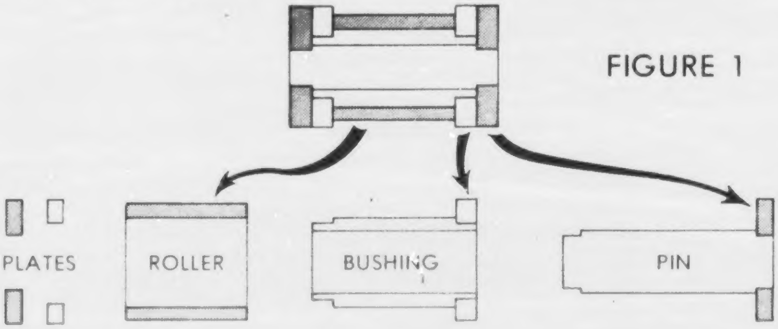


FIGURE 1

- E. Remove chain, allow to drain, and wipe off all excess grease from surface of chain

# CHAIN AND SPROCKET FINAL DRIVES
## UNIT I

## JOB SHEET #4--CHECK WHEEL TRACKING ALIGNMENT

I. Tools and materials

- A. Motorcycle
- B. Two straight edges about 6 feet long

  (NOTE: Two 2 X 4's, if accurately trued up, will do fine.)

- C. Machinist's steel rule or other suitable scale
- D. Safety glasses

II. Procedure

- A. Place motorcycle on level floor in an upright position
- B. Set front wheel in a straight ahead position
- C. Place straight edges on the sides of the rear wheel and observe the relationship to the front wheel (Figure 1)

  (NOTE: It should be parallel with the straight edge.)

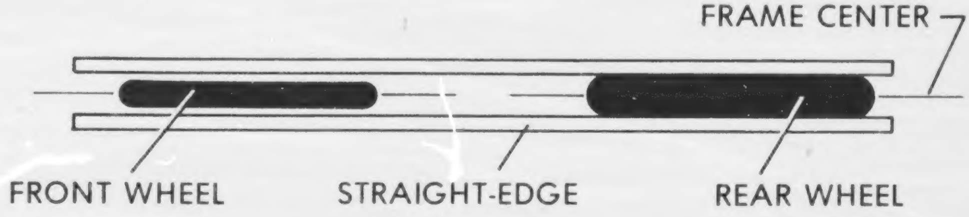


FIGURE 1

- D. Measure the distance between straight edges and side of front wheel

  (NOTE: Both measurements must be the same; if not, it will be necessary to realign the rear wheel.)

## CHAIN AND SPROKECT FINAL DRIVES
## UNIT I

### TEST

1. Match the terms on the right to the correct definitions.

______a. Thickness of the chain rollers

______b. Center to center distance between the pins of the chain

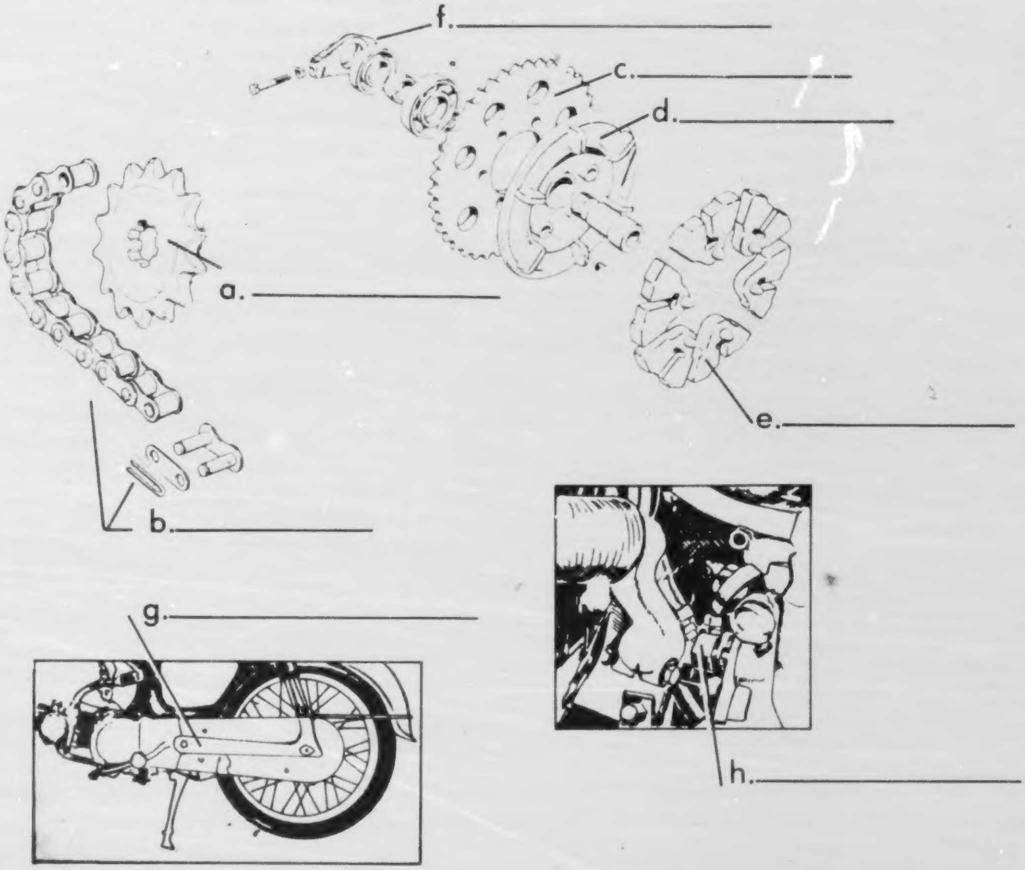
______c. Case that protects chain from excessive dirt and water

______d. Lengthening of the chain due to wear between the roller and bushing, and the bushing and pin

______e. Width between the inner side plates

1. Chain pitch
2. Chain stretch
3. Chain diameter
4. Chain width
5. Chain case

2. Identify the components of a chain and sprocket final drive.



3. List the purposes of a rear hub damper.

   a.

   b.

4. Describe the construction and sizing of a roller type chain.

   a. Construction

   b. Sizing determined by:

5. Select the causes of premature chain and sprocket wear by placing an "X" in the appropriate blanks.

   ______a. Prolonged high speed operation

   ______b. Operating in excessively dirty conditions

   ______c. Poor lubrication

   ______d. Improper tension

   ______e. Incorrect brand name of chain

   ______f. Failure to clean properly

   ______g. Overloading of vehicle

   ______h. Improper alignment

6. Demonstrate the ability to:

   a. Inspect and measure chain and sprockets.

   b. Adjust chain tension and alignment.

   c. Clean and lubricate chain.

   d. Check wheel tracking alignment.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

# CHAIN AND SPROCKET FINAL DRIVES
## UNIT I

## ANSWERS TO TEST

1. a. 3
   b. 1
   c. 5
   d. 2
   e. 4
2. a. Drive sprocket
   b. Drive chain with master link
   c. Driven or rear wheel sprocket
   d. Final drive flange or rear sprocket drum
   e. Rear hub damper
   f. Chain adjuster
   g. Chain case
   h. Chain oiler
3. a. Absorbs some of the shock of the final drive when the clutch is engaged and engine torque reaches rear wheel
   b. Provides some degree of protection for the drive train
4. Description should include:
   a. Construction
      1) Inner and outer plates, held together by steel pins, form links
      2) Pins attached to outer plates
      3) Bushings attached to inner plates
      4) Pins assembled through inside of bushings
      5) Rollers fit around outside of bushings

b. Sizing determined by:

  1) Pitch
  2) Width
  3) Roller diameter

5. b, c, d, f, h

6. Performance skills evaluated to the satisfaction of the instructor

# SHAFT FINAL DRIVES
## UNIT II

### UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms and definitions associated with shaft final drives and identify the components. The student should also be able to match shaft final drive components to their functions and distinguish between gear teeth wear patterns. The student should also be able to demonstrate the ability to remove, inspect, and install a shaft final drive unit. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

### SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with shaft final drives to the correct definitions.
2. Identify the major components of a shaft final drive.
3. Match shaft final drive components to their functions.
4. Distinguish between the correct, forward, and rearward gear teeth wear patterns.
5. Demonstrate the ability to:
    a. Remove, disassemble, and inspect final drive unit.
    b. Reassemble and adjust final drive unit.
    c. Remove and inspect drive shaft.
    d. Install drive shaft and final drive unit.

# SHAFT FINAL DRIVES
## UNIT II

## SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide student with objective sheet.
- B. Provide student with information and job sheets.
- C. Make transparencies.
- D. Discuss unit and specific objectives.
- E. Discuss information sheet.
- F. Demonstrate and discuss the procedures outlined in the job sheets.
- G. Obtain gear wear pattern illustrations from automotive publications.
- H. Give test.

II. Student:

- A. Read objective sheet.
- B. Study information sheet.
- C. Complete job sheets.
- D. Take test.

## INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheet
- C. Transparency masters
    1. TM 1--Shaft Final Drive Components
    2. TM 2--Gear Teeth Wear Patterns

D. Job sheets

1. Job Sheet #1--Remove, Disassemble, and Inspect Final Drive Unit
2. Job Sheet #2--Reassemble and Adjust Final Drive Unit
3. Job Sheet #3--Remove and Inspect Drive Shaft
4. Job Sheet #4--Install Drive Shaft and Final Drive Unit

E. Test

F. Answers to test

II. References:

A. *Motorcycle Service Manual.* Vol. 2. 3rd ed. Kansas City, Missouri: Technical Publishing Division/Intertec Publishing Co., 1972.

B. *Chilton's Motorcycle Repair Manual.* Radnor, Pennsylvania: Chilton Book Co., 1974.

C. *Honda GL1000 Shop Manual.* Gardena, California: American Honda Motor Co., 1976.

# SHAFT FINAL DRIVES
## UNIT II

## INFORMATION SHEET

I. Terms and definitions

   A. Universal joint (U-joint)--Coupling device capable of transmitting rotation between two shafts not in direct alignment

   B. Bevel gear--One of a pair of toothed wheels with inclined working surfaces

   C. Ring and pinion gears--Bevel gears used in the final drive unit to transmit rotation at right angles

   D. Preload--Load applied to bearing on assembly that is calculated by measuring its resistance to rotation

   E. Backlash--Clearance or freeplay between adjacent movable mechanical parts

   F. Axis--Straight line about which an object rotates

   G. Bearing bluing--Dark blue fluid that is applied to mechanical parts for marking of measurements or indication of contact patterns

   H. Toe--The forward or front of a gear tooth as viewed from the axis of the gear

   I. Heel--The rear part of a gear tooth as viewed from the axis of the gear

II. Major components of shaft final drive (Transparency 1)

   A. Swing arm

   B. Drive shaft

   C. Ring gear

   D. Pinion gear

   E. Universal joint

   F. Drive shaft coupling

   G. Final drive housing

## INFORMATION SHEET

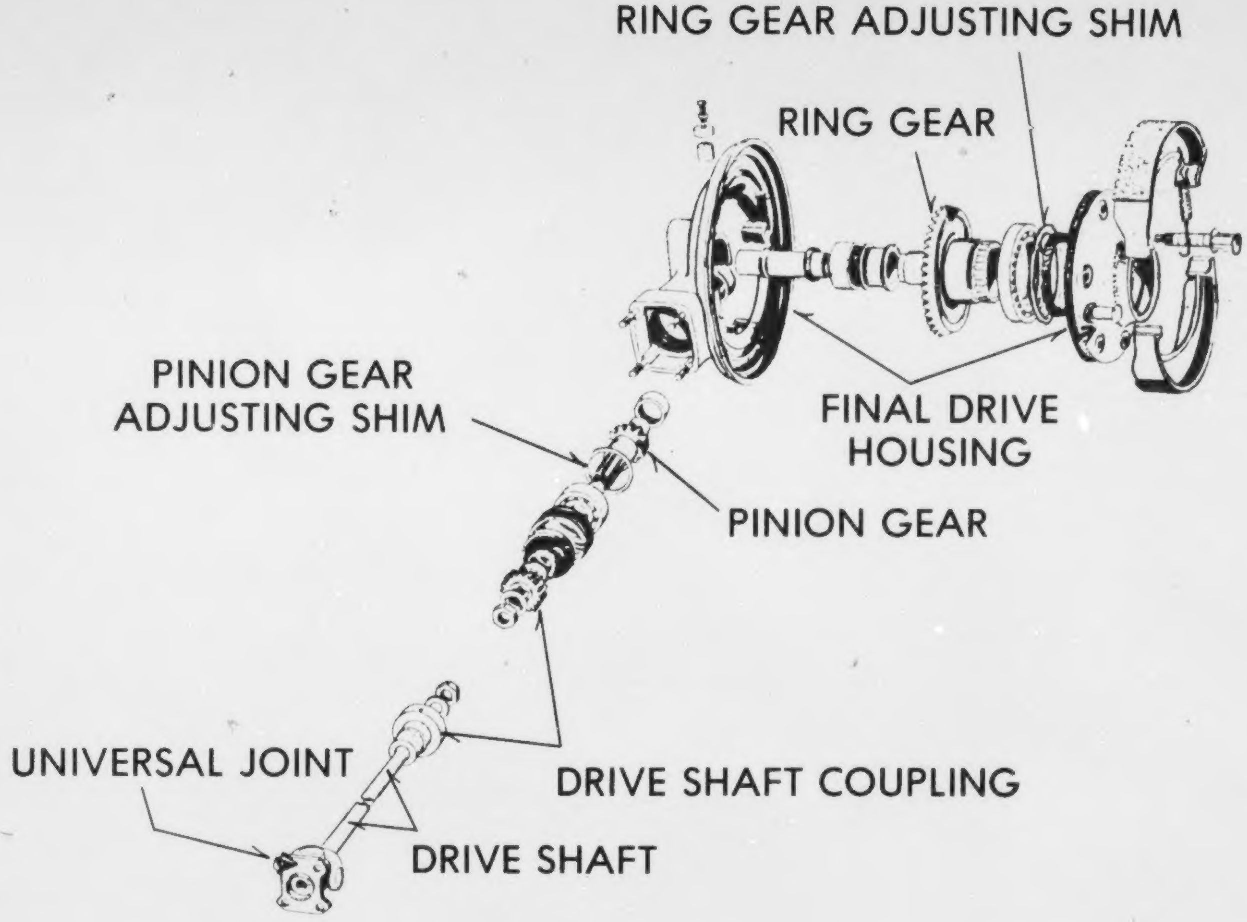
III. Functions of shaft final drive components

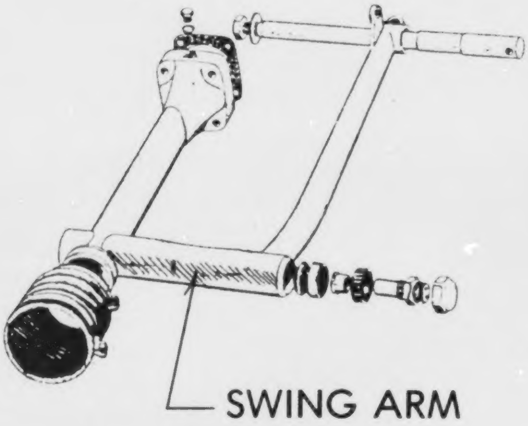
- A. Swing arm
  1. Locates and controls rear wheel
  2. Forms housing for drive shaft
- B. Universal joint
  1. Located on transmission end of drive shaft
  2. Allows drive shaft to move with rear suspension
- C. Drive shaft
  1. Transmits power from transmission to final drive unit
  2. Used in place of conventional chain
- D. Final drive housing
  1. Holds ring gear and pinion gear in rigid alignment
  2. Contains lubricating fluid
- E. Ring gear and pinion gear
  1. Transmits power from drive shaft to rear wheel
  2. Requires very little maintenance
- F. Drive shaft coupling
  1. Allows drive shaft to lengthen and shorten as rear suspension flexes
  2. Permits drive shaft removal without disassembly of ring and pinion gears

IV. Gear teeth wear patterns (Transparency 2)

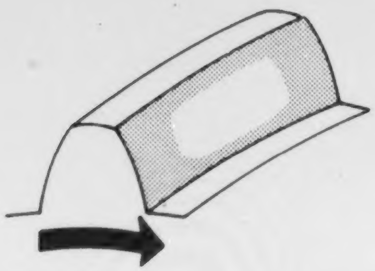
- A. Correct--Centered slightly forward
- B. Forward
  1. Adjust pinion closer to ring gear axis
  2. Adjust ring further away from pinion axis
- C. Rearward
  1. Adjust pinion further away from ring gear axis
  2. Adjust ring gear closer to pinion axis

# FINAL SHAFT DRIVE COMPONENTS

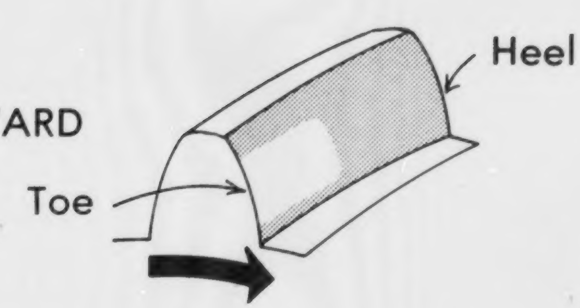

RING GEAR ADJUSTING SHIM
RING GEAR
PINION GEAR ADJUSTING SHIM
FINAL DRIVE HOUSING
PINION GEAR
UNIVERSAL JOINT
DRIVE SHAFT COUPLING
DRIVE SHAFT



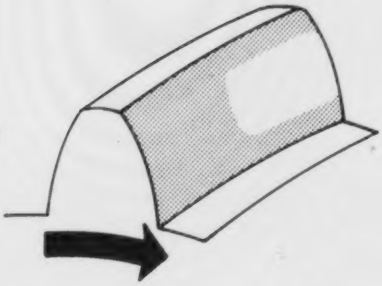
# GEAR TEETH WEAR PATTERNS



CORRECT



FORWARD



REARWARD

# SHAFT FINAL DRIVES
## UNIT II

## JOB SHEET #1--REMOVE, DISASSEMBLE, AND INSPECT FINAL DRIVE UNIT

I. Tools and materials

- A. Hand tool assortment
- B. Thermelt stick
- C. Plastic hammer
- D. Cleaning solvent
- E. Drain pan
- F. Parts washing pan
- G. Soft drift
- H. Seal protector
- I. Propane torch
- J. Special pin wrench
- K. Motorcycle with shaft final drive
- L. Appropriate service manual
- M. Safety glasses

II. Procedure

- A. Disconnect battery cable
- B. Place motorcycle on center stand
- C. Drain the final drive lubricant
- D. Remove both lower shock absorber mounting bolts
- E. Disconnect rear brake linkage
- F. Remove rear axle nut and rear axle

## JOB SHEET #1

G. Slide rear wheel to the left to disengage splines and remove rear wheel (Figure 1)

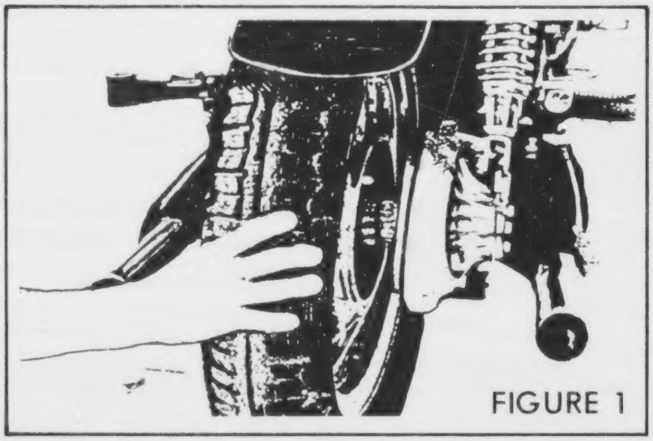


FIGURE 1

H. Reinstall left shock absorber bolt loosely to support swing arm

I. Remove bolts connecting final drive housing to drive shaft housing

J. Remove final drive unit

K. Remove the ring gear preload lock tab (Figure 2)

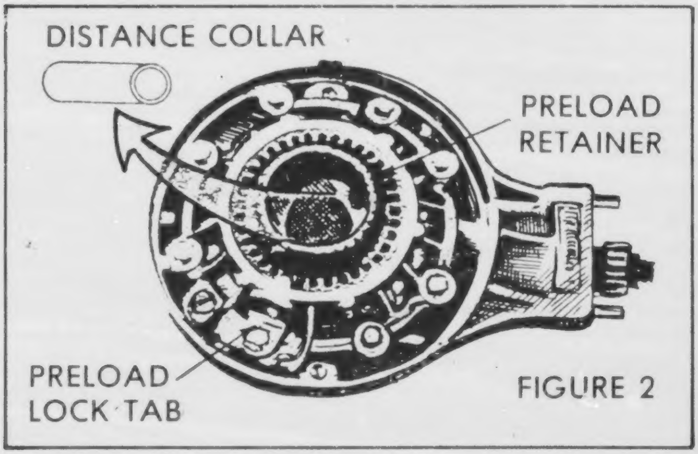

DISTANCE COLLAR
PRELOAD RETAINER
PRELOAD LOCK TAB

FIGURE 2

JOB SHEET #1

L. Remove the ring gear preload retainer using special pin wrench and a 1/2" break over handle (Figure 3)

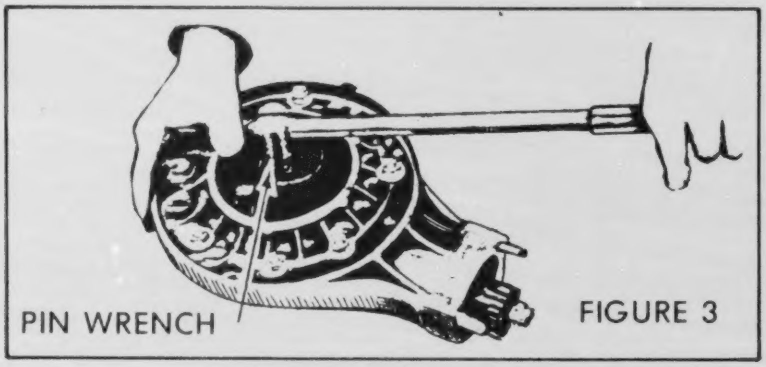


FIGURE 3

M. Remove the gearcase attaching bolts (Figure 4)

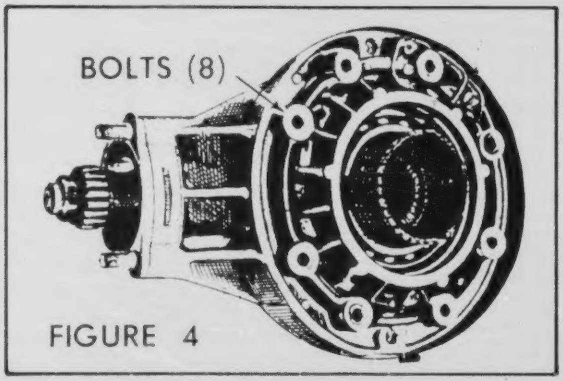


FIGURE 4

N. Remove the gearcase cover with ring gear

O. Drive the ring gear from the gearcase cover with a plastic hammer or use a hydraulic press (Figure 5)

(NOTE: To aid in disassembly, heat the gearcase cover to 170°F. Use thermelt heat stick to determine case temperature.)

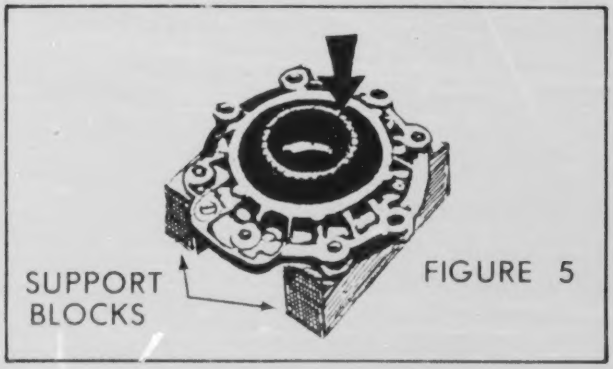


FIGURE 5

## JOB SHEET #1

P. Remove pinion shaft nut and washer

Q. Remove pinion shaft spline coupling (Figure 6)

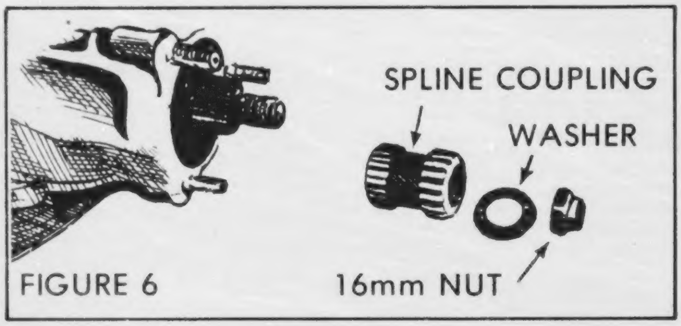


FIGURE 6

R. Remove the pinion gear and collar through the case

S. Clean and blow dry all parts

(CAUTION: Do not spin bearings with compressed air.)

T. Inspect ball and roller bearings for roughness; replace if necessary

U. Inspect gear teeth for correct wear patterns

V. Inspect all splines for excessive wear

W. Arrange all parts in order on clean shop towels in preparation for assembly

# SHAFT FINAL DRIVES
## UNIT II

## JOB SHEET #2-REASSEMBLE AND ADJUST FINAL DRIVE UNIT

I. Tools and materials

- A. Hand tool assortment
- B. Plastic hammer
- C. Seal driver set
- D. Bearing bluing
- E. Dial indicator with magnetic stand
- F. Pin wrench
- G. Multi-purpose grease
- H. Appropriate service manual
- I. Disassembled final drive unit
- J. Safety glasses

II. Procedure

- A. Replace seal in final drive housing
- B. Install spacer and collar on pinion shaft
- C. Install pinion in final drive housing
- D. Install front pinion bearing and seal (Figure 1)

  (NOTE: Lubricate shaft and seal with grease to prevent damage to seal.)

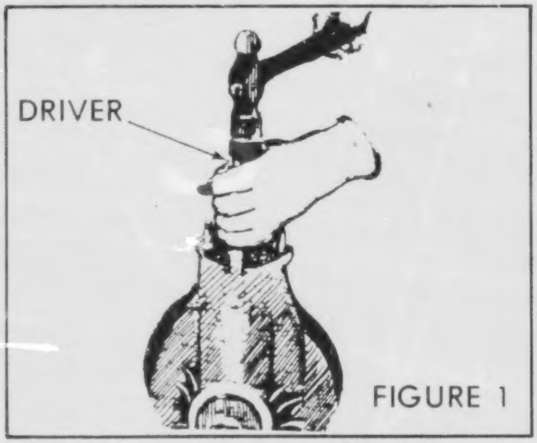


FIGURE 1

## JOB SHEET #2

E. Install spline coupling, washer, and 16 mm nut

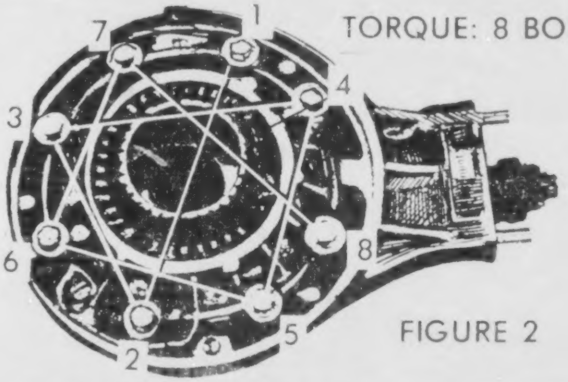
F. Torque nut to specifications

G. Check pinion preload with torque wrench to specifications in service manual

H. Coat teeth of both ring gear and pinion with bearing bluing

I. Install ring gear, spacer, gasket, and left gearcase cover in the final drive housing

J. Torque bolts in a criss-cross pattern with torque wrench to specifications in service manual (Figure 2)



TORQUE: 8 BOLTS

FIGURE 2

K. Rotate pinion shaft several revolutions

L. Remove left gearcase cover and ring gear from final drive housing

M. Inspect bluing on gear teeth to determine wear pattern

N. Adjust gear positions in final drive housing according to instructions in service manual and recheck

O. Install ring gear and left gearcase cover in final drive housing permanently when wear pattern is correct

P. Secure final drive unit to work bench

Example: • Clamp in a vise or clamp unit to work bench

JOB SHEET #2

Q. Set up dial indicator to contact pinion coupling splines (Figure 3)

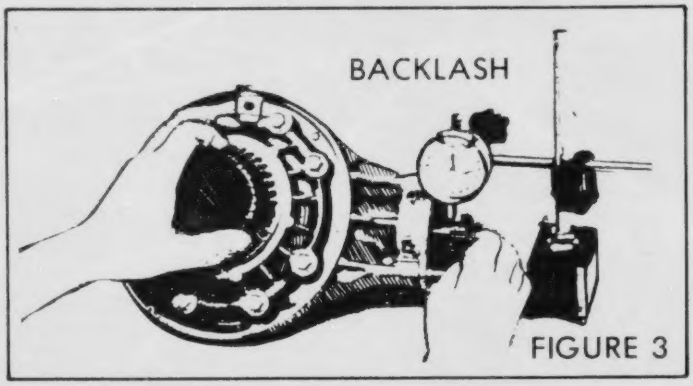


FIGURE 3

R. Hold ring gear splines securely, and turn pinion shaft back and forth to get backlash readings (Figure 3)

(NOTE: Consult service manual for correct specifications. If necessary adjust according to instructions in service manual.)

S. Check assembled preload prior to reinstallation

# SHAFT FINAL DRIVES
# UNIT II

## JOB SHEET #3--REMOVE AND INSPECT DRIVE SHAFT

I. Tools and materials

A. Hand tool assortment

B. Snap ring pliers

C. Cleaning solvent

D. Parts washing pan

E. Dial indicator and stand

F. Safety glasses

II. Procedure

A. Disconnect battery cable

B. Loosen swing arm pivot locknuts and back out pivots

C. Loosen universal joint rubber boot

D. Disconnect universal joint from transmission

E. Remove swing arm and drive shaft from vehicle

F. Inspect swing arm pivot bolts and bearings for damage

G. Remove drive shaft coupling from drive shaft

H. Remove drive shaft from swing arm

I. Inspect universal joint by rotating shaft and joint in opposite directions (Figure 1)

(NOTE: There should be no freeplay in the universal joint bearings.)

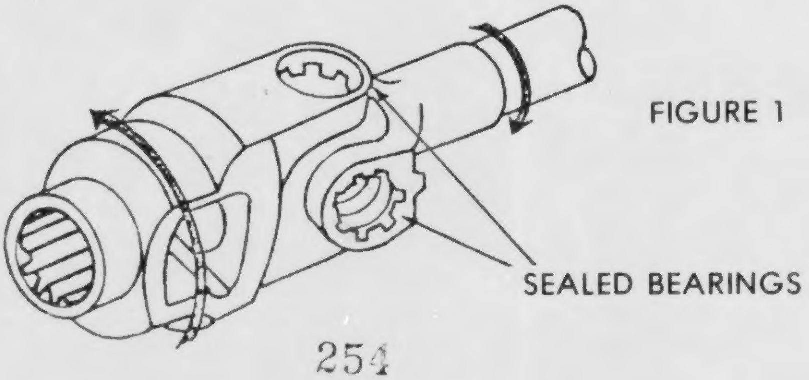


FIGURE 1

## JOB SHEET #3

J. Wash splines in cleaning solvent and blow dry

K. Inspect the splines of the drive shaft coupling and check the backlash (Figure 2)

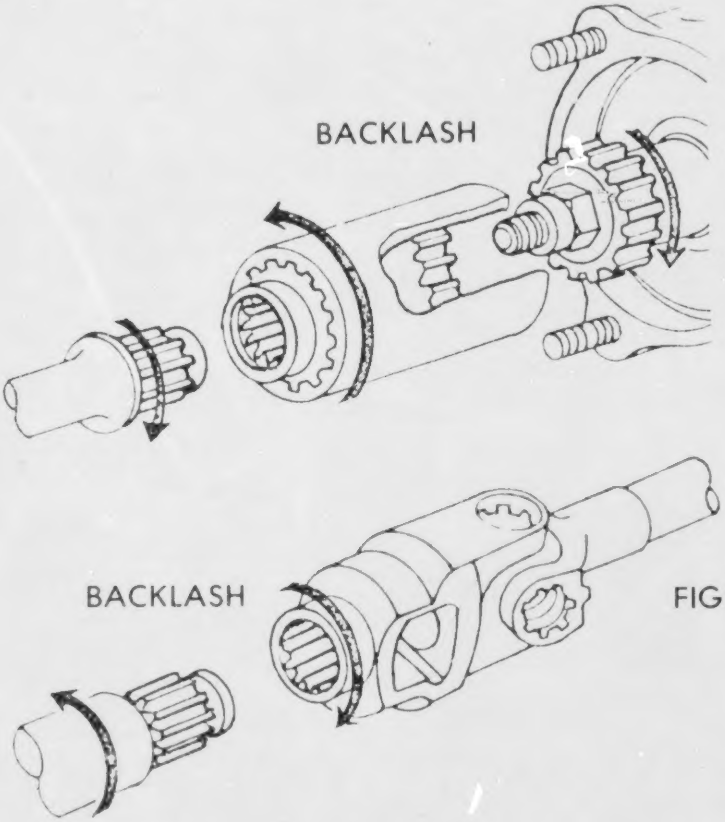


FIGURE 2

L. Check backlash at the universal joint and the transmission output shaft with dial indicator

(NOTE: Consult service manual for recommended tolerances.)

## SHAFT FINAL DRIVES
## UNIT II

## JOB SHEET #4--INSTALL DRIVE SHAFT AND FINAL DRIVE UNIT

I. Tools and materials

- A. Hand tool assortment
- B. Meter kilogram torque wrench
- C. Multi-purpose grease
- D. Hypoid gear oil
- E. Safety glasses

II. Procedures

- A. Lubricate all drive shaft splines (Figure 1)

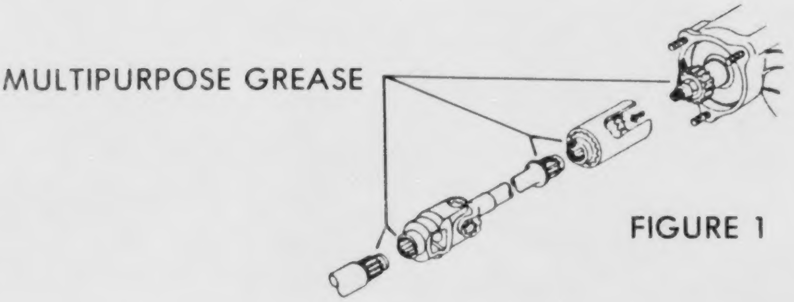

MULTIPURPOSE GREASE

FIGURE 1

- B. Install drive shaft into swing arm (Figure 2)

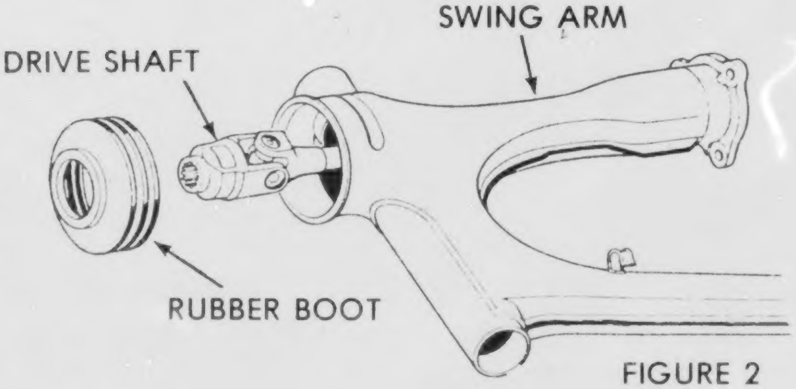

SWING ARM
DRIVE SHAFT
RUBBER BOOT

FIGURE 2

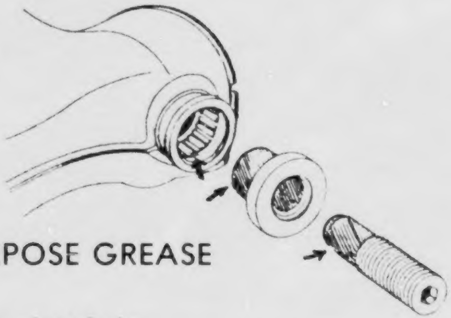
## JOB SHEET #4

C. Install swing arm into the vehicle

(NOTE: Align the universal joint and the transmission output shaft before the swing arm is fully in position.)

D. Lubricate swing arm pivot bolts and bearings (Figure 3)

FIGURE 3



E. Align swing arm and install pivot bolts

F. Torque pivot bolts according to specifications in service manual

G. Check swing arm for freedom of movement

(NOTE: If the swing arm will not move freely, back out the pivot bolts and check the condition of the bearings.)

H. Install pivot bolt locknuts and torque

(NOTE: Recheck swing arm for freedom of movement.)

I. Secure universal joint to transmission

J. Secure universal joint boot

K. Install drive shaft coupling and pack with small amount of multi-purpose grease

L. Install left lower shock absorber bolt loosely to support swing arm

M. Install final drive unit

N. Install and torque the bolts connecting final drive unit to drive shaft housing

## JOB SHEET #4

O. Lubricate ring gear drive splines (Figure 4)

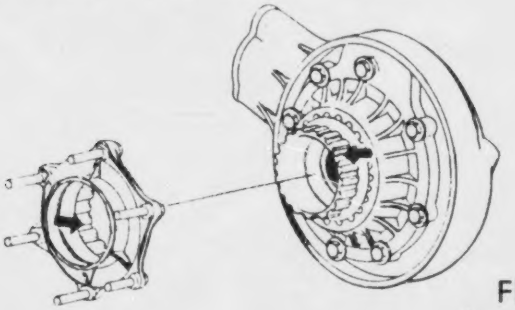


FIGURE 4

P. Remove left lower shock absorber bolt and allow swing arm to swing down

Q. Install rear wheel

R. Install rear axle and axle nut

S. Torque axle nut to specifications and install cotter pin

T. Install mounting bolts in lower end of both shock absorbers

U. Connect rear brake linkage

V. Fill final drive unit with hypoid gear oil

W. Check for free rotation of rear wheel

X. Connect battery cable

## SHAFT FINAL DRIVES
## UNIT II

### TEST

1. Match the terms on the right to the correct definitions.

______a. Straight line about which an object rotates

______b. Clearance or freeplay between adjacent movable mechanical parts

______c. Load applied to bearing on assembly that is calculated by measuring its resistance to rotation

______d. Bevel gears used in the final drive unit to transmit rotation at right angles

______e. One of a pair of toothed wheels with inclined working surfaces

______f. Coupling device capable of transmitting rotation between two shafts not in direct alignment

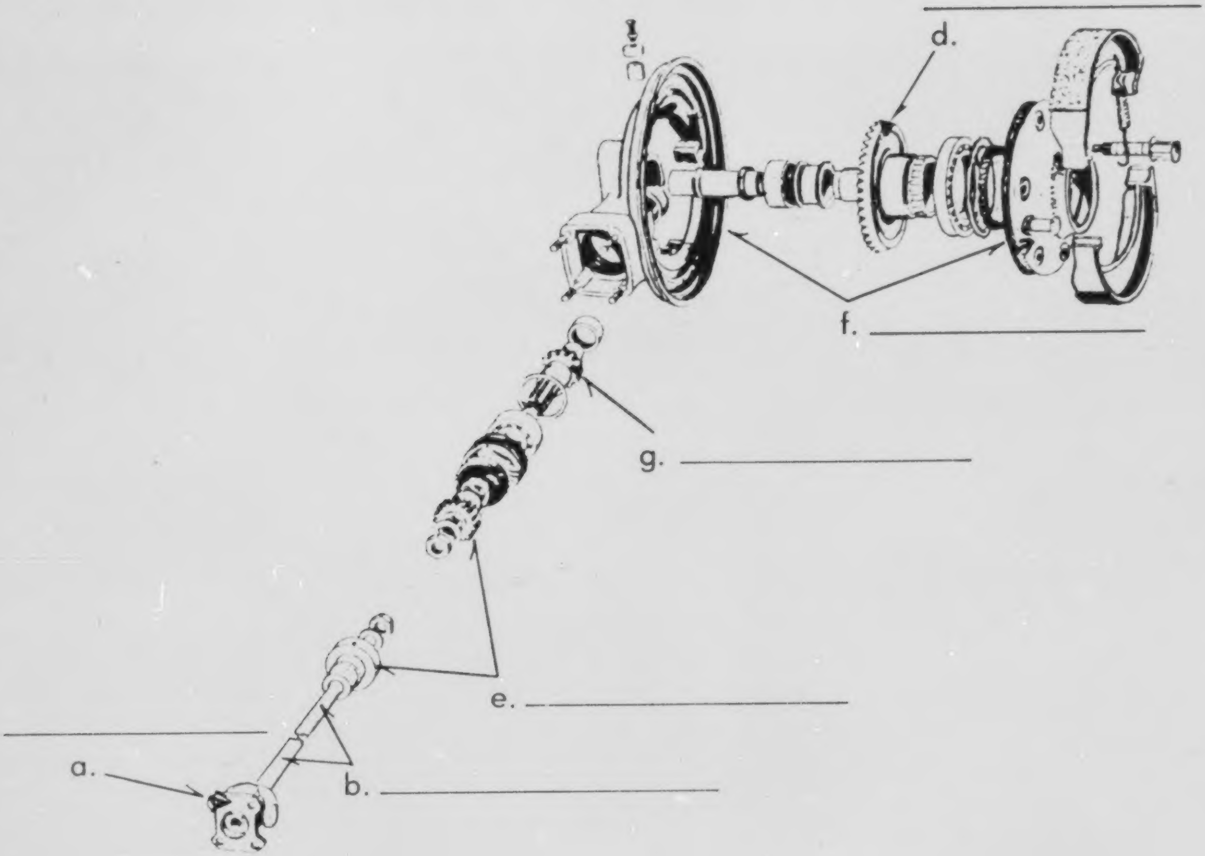
______g. Dark blue fluid that is applied to mechanical parts for marking of measurements or indication of contact patterns

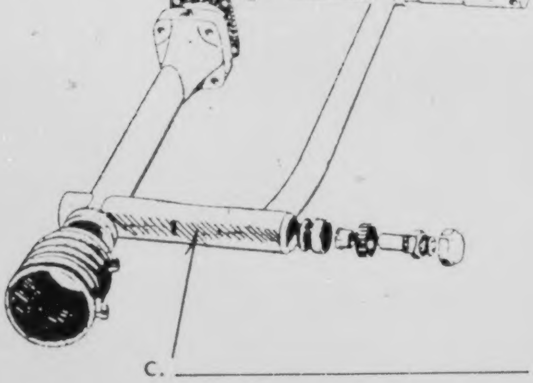
______h. The forward or front of a gear tooth as viewed from the axis of the gear

______i. The rear part of a gear tooth as viewed from the axis of the gear

1. Preload
2. Bevel gear
3. Backlash
4. Universal joint (U-joint)
5. Axis
6. Ring and pinion gears
7. Heel
8. Toe
9. Bearing bluing

2. Identify the major components of a shaft final drive.





3. Match the shaft final drive components on the right to their functions.

____a.
  1) Locates and controls rear wheel
  2) Forms housing for drive shaft

____b.
  1) Located on transmission end of drive shaft
  2) Allows drive shaft to move with rear suspension

____c.
  1) Transmits power from transmission to final drive unit
  2) Used in place of conventional chain

____d.
  1) Holds ring gear and pinion gear in rigid alignment
  2) Contains lubricating fluid

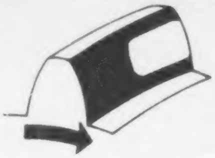
____e.
  1) Transmits power from drive shaft to rear wheel
  2) Requires very little maintenance

____f.
  1) Allows drive shaft to lengthen and shorten as rear suspension flexes
  2) Permits drive shaft removal without disassembly of ring and pinion gears

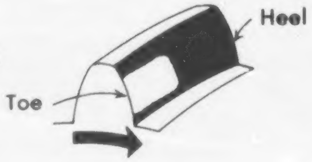
1. Final drive housing
2. Universal joint
3. Drive shaft coupling
4. Swing arm
5. Drive shaft
6. Ring gear and pinion gear

4. Distinguish between the correct, forward, and rearward gear teeth wear patterns by placing an "X" next to the picture of the correct wear pattern.

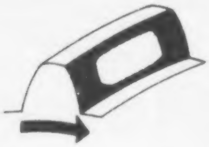
______a.



______b.



______c.



5. Demonstrate the ability to:

a. Remove, disassemble, and inspect final drive unit.

b. Reassemble and adjust final drive unit.

c. Remove and inspect drive shaft.

d. Install drive shaft and final drive unit.

(NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

## SHAFT FINAL DRIVES
## UNIT II

### ANSWERS TO TEST

1. a. 5
   b. 3
   c. 1
   d. 6
   e. 2
   f. 4
   g. 9
   h. 8
   i. 7
2. a. Universal joint
   b. Drive shaft
   c. Swing arm
   d. Ring gear
   e. Drive shaft coupling
   f. Final drive housing
   g. Pinion gear
3. a. 4
   b. 2
   c. 5
   d. 1
   e. 6
   f. 3
4. c
5. Performance skills evaluated to the satisfaction of the instructor

# WHEEL LACING AND TRUING
## UNIT I

## UNIT OBJECTIVE

After completion of this unit, the student should be able to identify spokes and cross spoke patterns and demonstrate the ability to remove and replace a rim, lace a wheel, true a wheel, and replace spokes. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with wheel lacing and truing to the correct definitions.
2. Identify the inner spoke and the outer spoke.
3. Identify the cross spoke patterns.
4. Demonstrate the ability to:
    a. Remove and replace a rim.
    b. Lace a wheel.
    c. True a wheel.
    d. Replace spokes.

# WHEEL LACING AND TRUING
## UNIT I

## SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss the procedures outlined in the job sheets.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheets.

   D. Take test.

## INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Wheel Spokes

      2. TM 2--Cross 1 Spoke Pattern

      3. TM 3--Cross 2 Spoke Pattern

      4. TM 4--Cross 4 Spoke Pattern

D. Job sheets

   1. Job Sheet #1--Remove and Replace a Rim

   2. Job Sheet #2--Lace a Wheel

   3. Job Sheet #3--True a Wheel

   4. Job Sheet #4--Replace Spokes

E. Test

F. Answers to test

II. References:

A. *Motorcycle Service Manual.* Vol. 1. 3rd ed. Kansas City, Missouri: Technical Publications Division/Intertec Publishing Corp., 1972.

B. *Harley-Davidson Service Manual.* Milwaukee, Wisconsin: Harley-Davidson Motor Co., 1971.

C. *Chilton's New Motorcycle Troubleshooting Guide.* Radnor, Pennsylvania: Chilton Book Co., 1973.

D. *Suzuki 350 Parts Catalogue.* Suzuki Motor Co., Ltd., 1969.

III. Additional material--Cassette tape--Wheel Lacing and Truing. Kawasaki Motor Corp., P.O. Box 11447, 1062 McGraw Avenue, Santa Ana, California 92711.

# WHEEL LACING AND TRUING
## UNIT I

## INFORMATION SHEET

I. Terms and definitions

A. Lacing--Replacing or installing spokes in the correct pattern

B. Truing--Centering the hub in the rim by adjusting the spokes for length and tension

C. Tensile strength--Resistance of the spoke to stretch when an end to end pull is applied

D. Cross spoke pattern--Number of spokes crossed by another on the same side of the hub

E. Spoke nipple--Long, thin nuts that screw onto the rim end of the spoke

F. Inner spokes--Spokes that fit the inside of the hub

G. Outer spokes--Spokes that fit the outside of the hub

H. Lateral runout--Side to side movement of a circular object as it rotates on its axis

(NOTE: This is also known as side runout.)

I. Radial runout--Up and down movement of the wheel as it spins

II. Inner and outer spokes (Transparency 1)

A. Inner spoke--More than 90° bend at spoke head

B. Outer spoke--Less than 90° bend at spoke head

III. Cross spoke patterns

A. Cross 0 spoke pattern--No spoke crosses any other spoke on the same side of the hub

(NOTE: This pattern is never used in motorcycle wheels because of its inherent weakness.)

B. Cross 1 spoke pattern--One spoke crosses one other spoke on the same side of the hub (Transparency 2)

(NOTE: This pattern is used very little because of its weakness.)

## INFORMATION SHEET

C. Cross 2 spoke pattern--One spoke crosses two other spokes on the same side of the hub (Transparency 3)

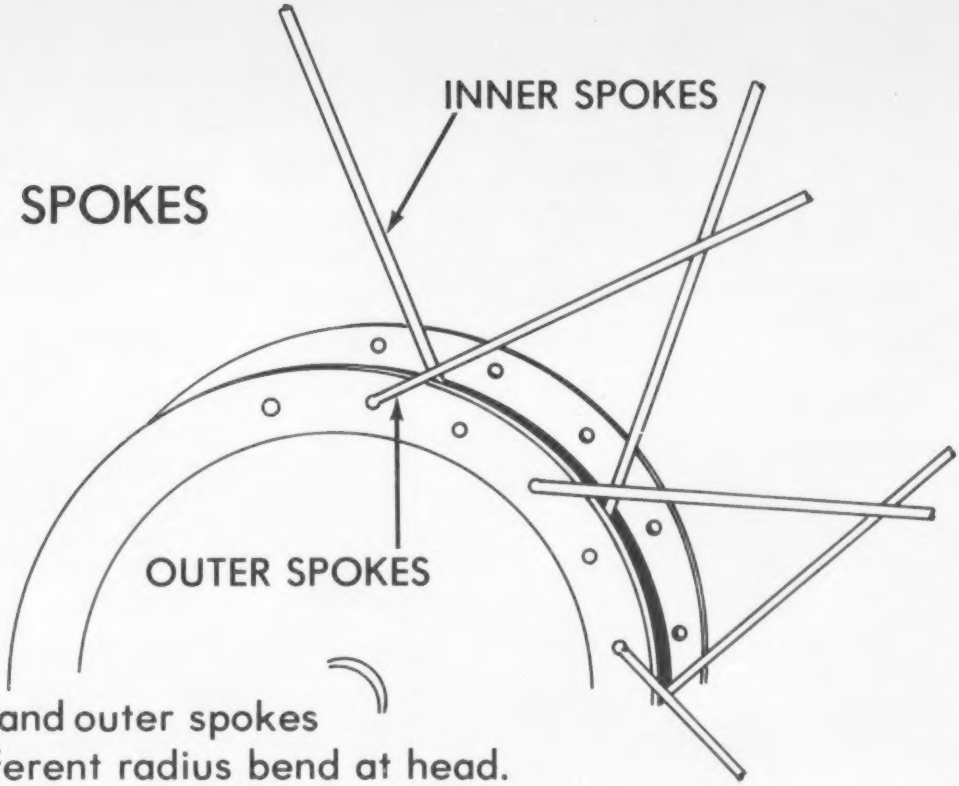
(NOTE: This pattern is used extensively.)

D. Cross 3 spoke pattern--One spoke crosses three other spokes on the same side of the hub

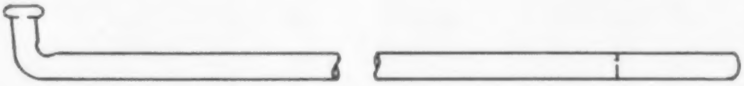
E. Cross 4 spoke pattern--One spoke crosses four other spokes on the same side of the hub (Transparency 4)

(NOTE: Cross 3 and 4 spoke patterns have excellent strength and are used on larger and heavier motorcycles.)

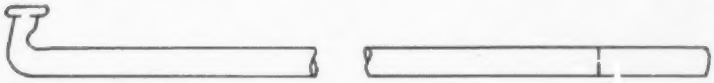
# WHEEL SPOKES


INNER SPOKES
OUTER SPOKES

Inner spokes and outer spokes
may have different radius bend at head.

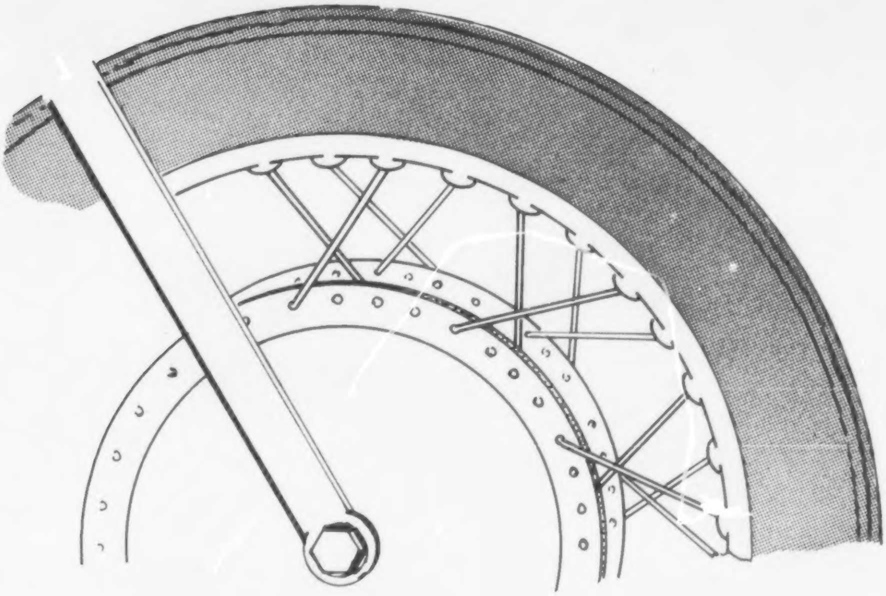


INNER SPOKE - -
MORE THAN 90° BEND AT SPOKE HEAD



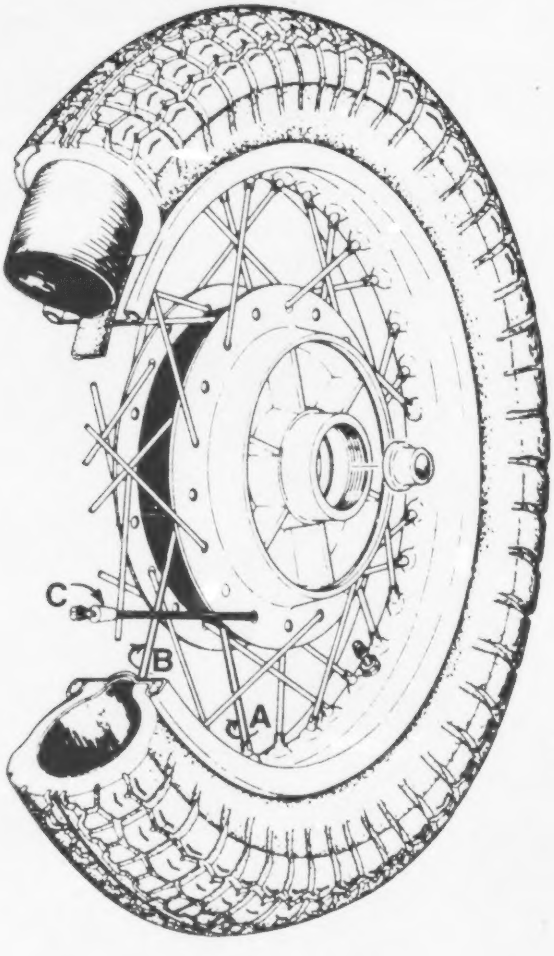
OUTER SPOKE - -
LESS THAN 90° BEND AT SPOKE HEAD

# CROSS 1 SPOKE PATTERN



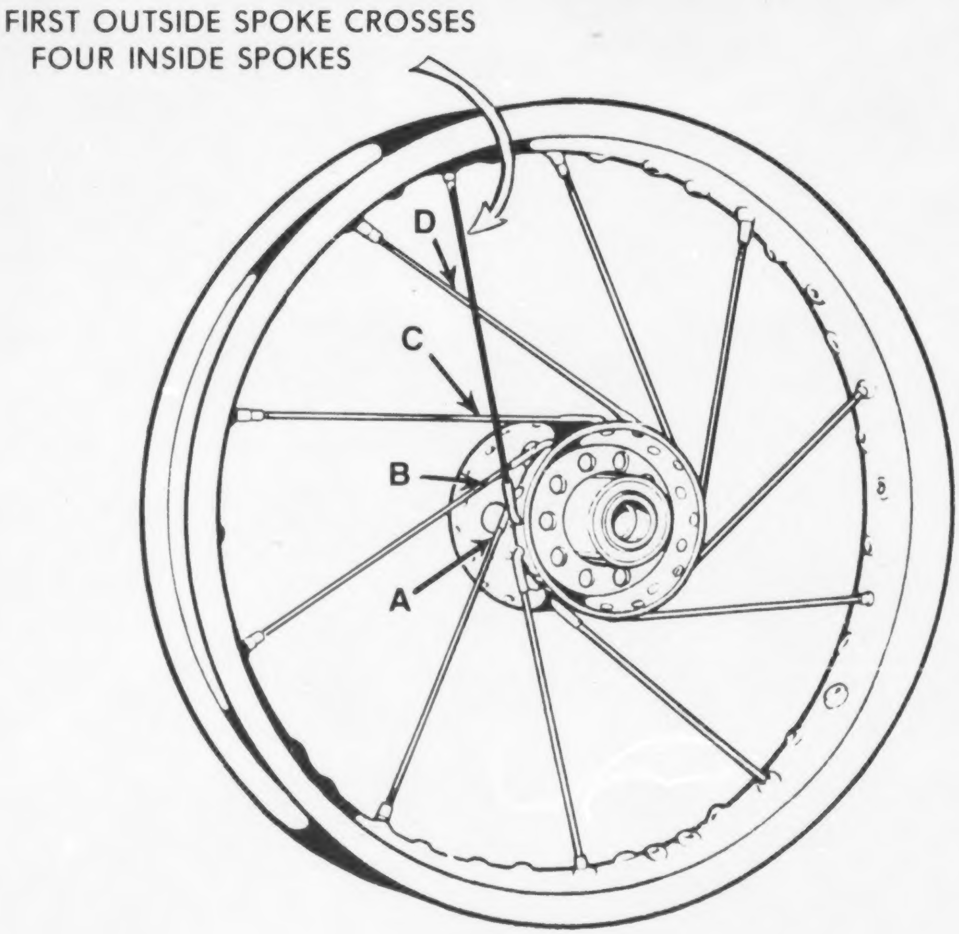
NOTE: INDIVIDUAL SPOKES CROSS
ONLY ONE OTHER SPOKE
ON THE SAME SIDE OF THE HUB.

# CROSS 2 SPOKE PATTERN



NOTE: SPOKE "C" CROSSES SPOKES "A" AND "B".

# CROSS 4 SPOKE PATTERN


FIRST OUTSIDE SPOKE CROSSES
FOUR INSIDE SPOKES
D
C
B
A

NOTE: SPOKES "A", "B", "C", AND "D" ARE ALL CROSSED.

# WHEEL LACING AND TRUING
## UNIT I

## JOB SHEET #1--REMOVE AND REPLACE A RIM

I. Tools and materials

A. Nipple wrench or adjustable end wrench

B. Grease pencil

C. Roll of tape

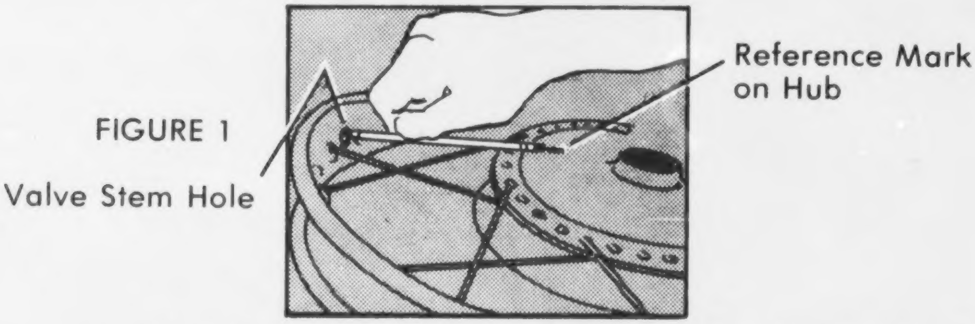
D. Motorcycle wheel without tire and tube

E. Safety glasses

II. Procedure

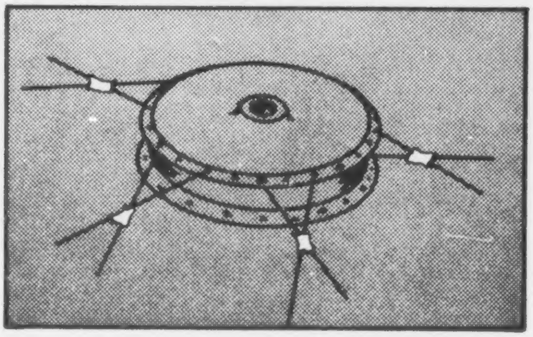
A. Locate the valve stem hole in the rim and in direct alignment with it, make a reference mark on the hub (Figure 1)

FIGURE 1



B. Tape the spokes together in pairs where they cross and form an X (Figure 2)

FIGURE 2



C. Remove the nipples from all spokes

D. Slowly and carefully work the rim free of the spokes

E. Check the taping on the spokes and retape any that need it

## JOB SHEET #1

F. To replace the rim, set it back over the hub and spokes, aligning the valve stem hole with the reference mark on the hub

G. Starting at the valve stem hole, carefully work one taped pair of spokes at a time through the rim holes, and screw the nipples on just a few turns

H. Continue this procedure until all spokes are inserted and each nipple is on a few turns

I. Starting at the valve stem hole tighten each nipple 1/2 turn, working in one direction only

J. Continue to work around the rim until all spokes are tightened to the same tension

# WHEEL LACING AND TRUING
## UNIT I

## JOB SHEET #2--LACE A WHEEL

I. Tools and materials

   A. Nipple wrench or adjustable end wrench

   B. Motorcycle wheel without tire and tube

   C. Wheel truing stand

   D. Grease pencil

   E. Safety glasses

II. Procedure

   A. Identify the cross spoke pattern

   B. Remove spoke nipples and spokes

   (NOTE: Keep ali inner spokes separated from the outer spokes because they should not be interchanged.)

   C. Separate hub and rim

   D. To reassemble, install all outer spokes, then all inner spokes on one side of the hub

   E. Invert hub and install remaining spokes correctly

   F. Arrange the spokes in their approximate pattern

   G. Place wheel rim in position

   H. Working with one row at a time, install the spokes and nipples

# WHEEL LACING AND TRUING
## UNIT I

## JOB SHEET #3--TRUE A WHEEL

I. Tools and materials

   A. Wheel truing stand

   B. Nipple wrench or adjustable end wrench

   C. Grease pencil

   D. Motorcycle wheel without tire and tube

   E. Safety glasses

II. Procedure

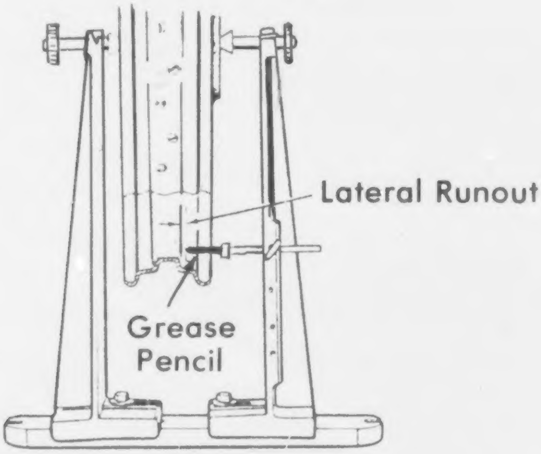
   A. Mount wheel on truing stand

   B. Check lateral runout

      1. Spin the wheel and hold the grease pencil at right angles to the outside edge of the wheel rim (Figure 1)

         (NOTE: The pencil will leave a mark on the rim at the point at which lateral runout is greatest.)

FIGURE 1



      2. To correct lateral runout, loosen spokes on the marked side of the rim 1/2 turn and tighten the spokes opposite the marked side of the rim 1/2 turn

      3. Remove grease pencil mark from rim and repeat checking and adjustment until runout does not exceed 1/32 of an inch

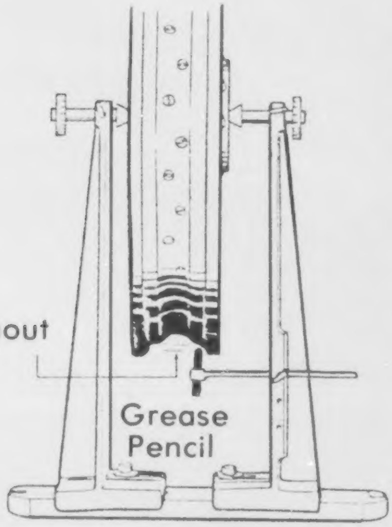
## JOB SHEET #3

C. Check radial runout

1. Spin the wheel and hold the grease pencil parallel with the wheel rim (Figure 2)

   (NOTE: The pencil will mark the high spot on the rim.)

FIGURE 2



2. To correct radial runout, loosen the spokes directly opposite the marked area 1/2 turn and tighten the spokes at the marked area 1/2 turn

3. Remove grease pencil mark from rim and repeat the adjustment until runout does not exceed 1/32 of an inch

D. After adjusting radial runout, recheck and readjust the lateral runout, if necessary

# WHEEL LACING AND TRUING
## UNIT I

## JOB SHEET #4--REPLACE SPOKES

I. Tools and materials

A. Assortment of replacement spokes

B. Nipple wrench or adjustable end wrench

C. Tire pressure gauge

D. Safety glasses

II. Procedure

(NOTE: The following procedure is recommended only when a few spokes must be replaced.)

A. Release a small amount of air from the tire

(NOTE: Do not flatten the tire.)

B. If the spoke to be replaced is not already broken, it can be cut and the hooked end removed from the hub

C. Unscrew spoke from nipple

(NOTE: Be careful not to force nipple into rim.)

D. Insert replacement spoke through hub and attach to nipple

(NOTE: It may be necessary to bend the spoke slightly to install it, but it should pull straight when tightened.)

E. Tighten spoke with a nipple wrench or a small adjustable wrench to the same tension as the other spokes

(NOTE: If the new spoke extends beyond the nipple on the inside of the rim, there is the danger of puncturing the tube. When in doubt, the tire and tube should be dismounted and the spoke checked.)

F. Inflate tire to correct pressure

# WHEEL LACING AND TRUING
## UNIT I

## TEST

1. Match the terms on the right to the correct definitions.

_____a. Centering the hub in the rim by adjusting the spokes for length and tension

_____b. Resistance of the spoke to stretch when an end to end pull is applied

_____c. Spokes that fit the outside of the hub

_____d. Side to side movement of a circular object as it rotates on its axis

_____e. Replacing or installing spokes in the correct pattern

_____f. Up and down movement of the wheel as it spins

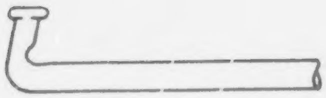
_____g. Number of spokes crossed by another on the same side of the hub

_____h. Long, thin nuts that screw onto the rim end of the spoke

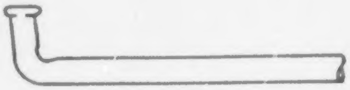
_____i. Spokes that fit the inside of the hub

1. Outer spokes
2. Lateral runout
3. Radial runout
4. Lacing
5. Tensile strength
6. Truing
7. Cross spoke pattern
8. Spoke nipple
9. Inner spokes

2. Identify the inner spoke and the outer spoke.

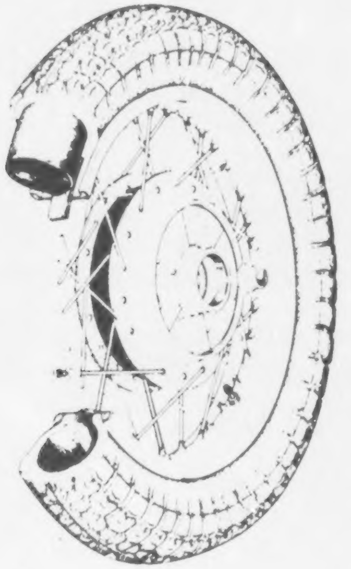


a. ______________________

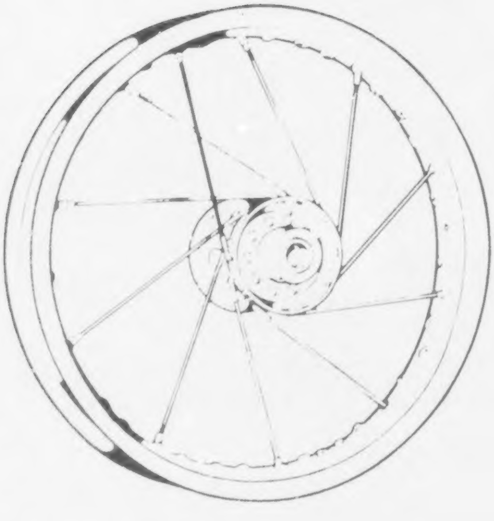


b. ______________________

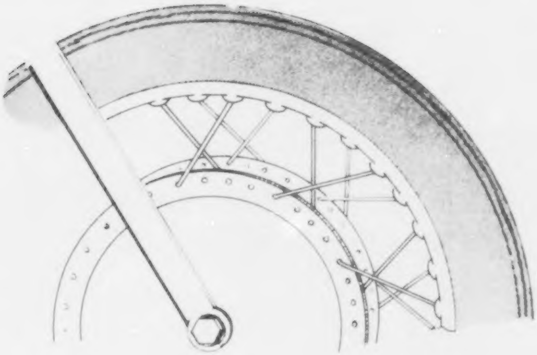
3. Identify the cross spoke patterns.



a. ____________________



b. ____________________



c. ____________________

4. Demonstrate the ability to:

   a. Remove and replace a rim.

   b. Lace a wheel.

   c. True a wheel.

   d. Replace spokes.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

## WHEEL LACING AND TRUING
## UNIT I

### ANSWERS TO TEST

1. a. 6
   b. 5
   c. 1
   d. 2
   e. 4
   f. 3
   g. 7
   h. 8
   i. 9

2. a. Outer spoke
   b. Inner spoke

3. a. Cross 2 spoke pattern
   b. Cross 4 spoke pattern
   c. Cross 1 spoke pattern

4. Performance skills evaluated to the satisfaction of the instructor

# WHEEL BEARINGS, AXLES, AND BALANCING
## UNIT II

## UNIT OBJECTIVE

After completion of this unit, the student should be able to identify types of wheel bearings, and remove, inspect, and service the wheel bearings. The student should also be able to inspect the axles and static balance the wheels. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Identify types of motorcycle wheel bearings.
2. Match types of wheel bearings to the correct construction characteristics.
3. Demonstrate the ability to:
    a. Service wheel bearings and related parts.
    b. Static balance a wheel.

# WHEEL BEARINGS, AXLES, AND BALANCING
## UNIT II

## SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss the procedures outlined in the job sheets.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheets.

   D. Take test.

## INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Roller Bearing and Tapered Roller Bearing

      2. TM 2--Ball Cone Bearing and Ball Bearing

D. Job sheets

  1. Job Sheet #1--Service Wheel Bearings and Related Parts

  2. Job Sheet #2--Static Balance a Wheel

E. Test

F. Answers to test

II. References:

A. *Harley-Davidson Service Manual - Electra Glide 1959-1969.* Milwaukee, Wisconsin: Harley-Davidson Motor Co., 1971.

B. *Chilton's Harley-Davidson Singles Repair and Tune-Up Guide.* Radnor, Pennsylvania: Chilton Book Co., 1973.

C. *Chilton's BMW Motorcycle Repair and Tune-Up Guide.* Radnor, Pennsylvania: Chilton Book Co., 1973.

D. *Honda 450 Service Manual.* Honda Motor Co., Ltd., 1971.

E. *Suzuki GT 550 Service Manual.* 2nd ed. Suzuki Motor Co., Ltd.

F. *Fundamentals of Service: Bearings and Seals.* 2nd ed. Moline, Illinois: Deere & Co., 1974.

# WHEEL BEARINGS, AXLES, AND BALANCING
## UNIT II

## INFORMATION SHEET

I. Types of motorcycle wheel bearings (Transparencies 1 and 2)

   A. Roller bearing

   B. Tapered roller bearing

   C. Ball cone bearing

   D. Ball bearing

II. Construction characteristics of wheel bearings

   A. Roller bearing

      1. Consists of individual rollers set into a roller retainer with inner and outer races

      2. Adjusted by use of shims

   B. Tapered roller bearing

      1. Consists of tapered rollers set into retainer with tapered inner and outer races

      2. Adjusted by movement of the inner race

   C. Ball cone bearing

      1. Consists of steel balls set into retaining cage with inner and outer races and semicircular channels for balls

      2. Adjusted by means of moving threaded inner cone race

   D. Ball bearing

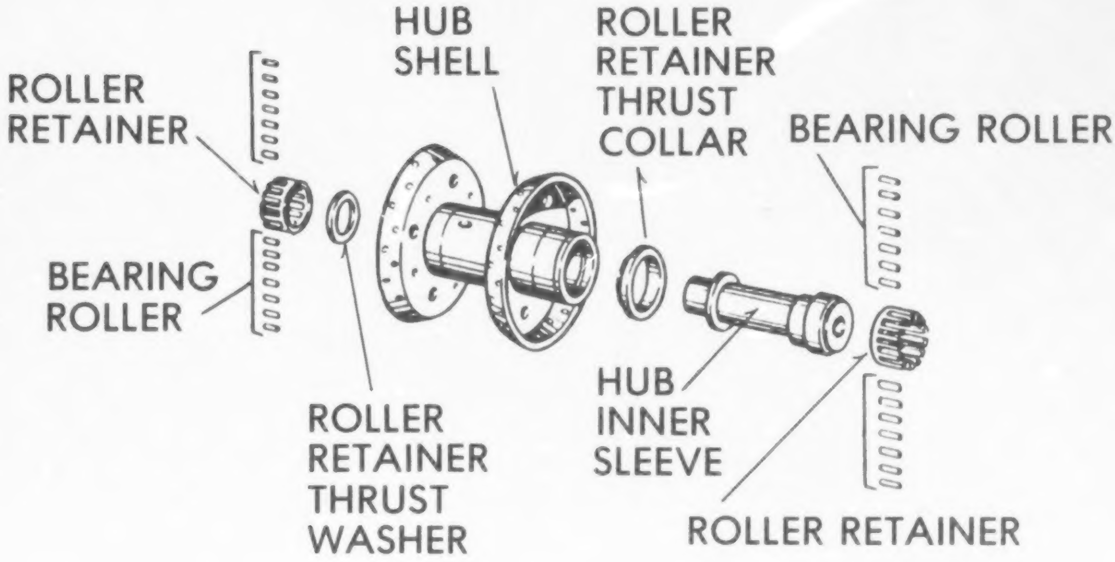
      1. Consists of steel balls with inner and outer races assembled as one piece

      2. Adjustment not necessary

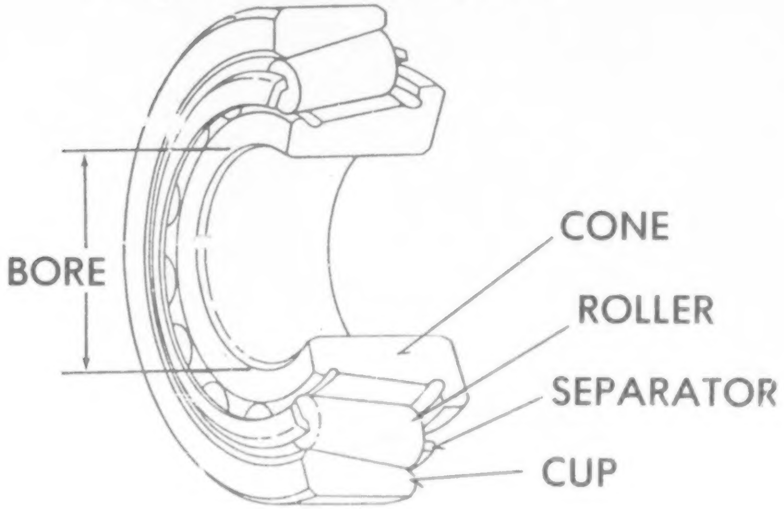
   (NOTE: The ball bearing is the most common type of motorcycle wheel bearing used today. These may be sealed or open.)

# ROLLER BEARING AND TAPERED ROLLER BEARING

## ROLLER BEARING

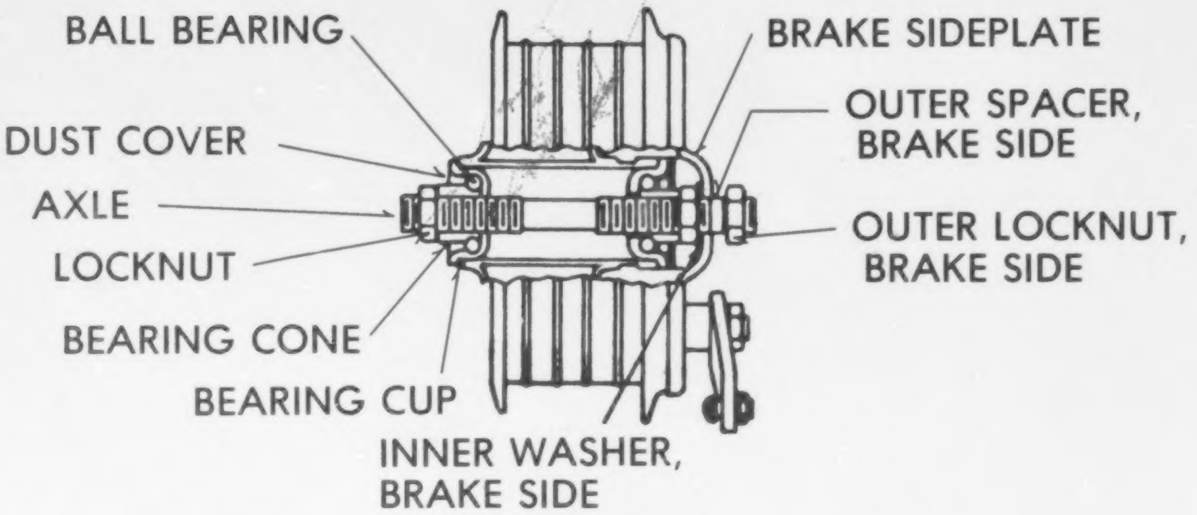

HUB
SHELL
ROLLER
RETAINER
THRUST
COLLAR
ROLLER
RETAINER
BEARING ROLLER
BEARING
ROLLER
ROLLER
RETAINER
THRUST
WASHER
HUB
INNER
SLEEVE
ROLLER RETAINER

## TAPERED ROLLER BEARING

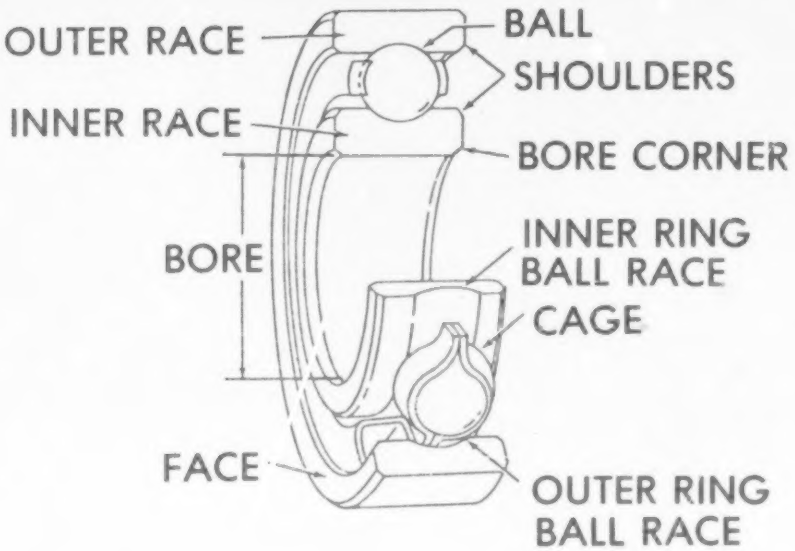

BORE
CONE
ROLLER
SEPARATOR
CUP

# BALL CONE BEARING AND BALL BEARING

## BALL CONE BEARING


BALL BEARING
DUST COVER
AXLE
LOCKNUT
BEARING CONE
BEARING CUP
INNER WASHER, BRAKE SIDE
BRAKE SIDEPLATE
OUTER SPACER, BRAKE SIDE
OUTER LOCKNUT, BRAKE SIDE

## BALL BEARING


OUTER RACE
INNER RACE
BORE
FACE
BALL
SHOULDERS
BORE CORNER
INNER RING BALL RACE
CAGE
OUTER RING BALL RACE

# WHEEL BEARINGS, AXLES, AND BALANCING
## UNIT II

## JOB SHEET #1--SERVICE WHEEL BEARINGS AND RELATED PARTS

I. Tools and materials

   A. Hand tool assortment

   B. Metric wrench set

   C. Brass drift or bushing driver set

   D. Parts cleaning pan, brush, and solvent

   E. Pry bar

   F. Wheel bearing grease

   G. Shop towels

   H. "V" blocks (2)

   I. Dial indicator

   J. Safety glasses

II. Procedure

   A. Remove axle nut and axle (Figure 1)

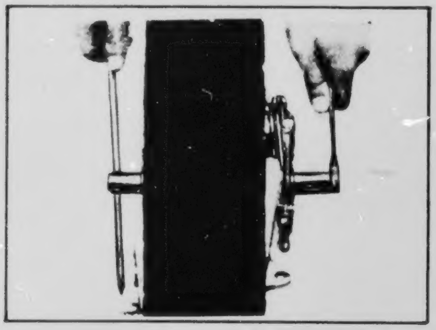


FIGURE 1

## JOB SHEET #1

B. Pry out wheel seals with pry bar (Figure 2)

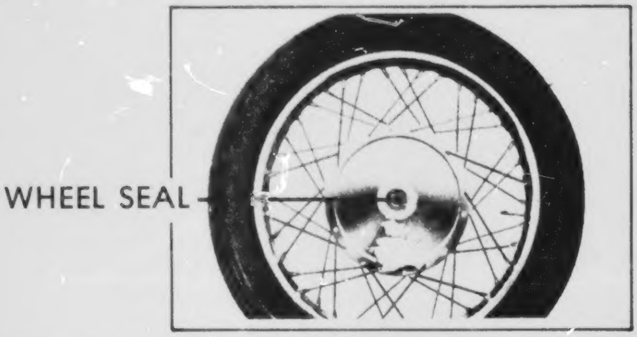


FIGURE 2

C. Drive out the wheel bearings using the brass drift or bushing drivers and hammer (Figure 3)

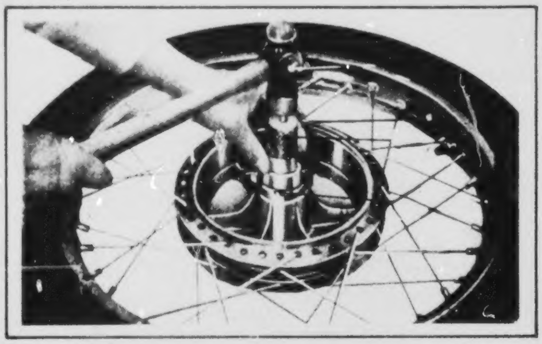


FIGURE 3

D. Wash all parts in clean solvent

E. Wipe excess cleaning solvent off of bearings and other parts with shop towels

F. Inspect bearings for pits or roughness

(NOTE: Spin the bearing by hand; it should feel smooth and not catch or bind.)

G. Check the axle for bend by using the "V" blocks and dial indicator (Figure 4)

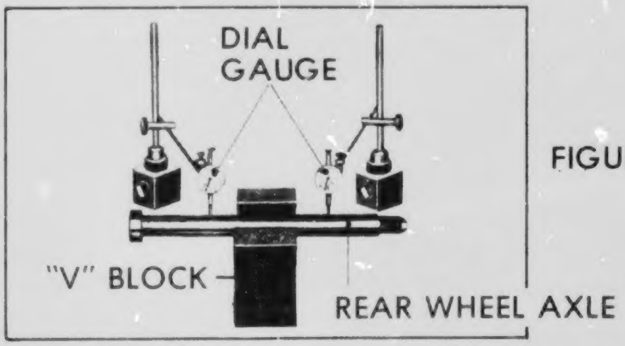


FIGURE 4

## JOB SHEET #1

H. Pack bearings with wheel bearing grease

(NOTE: Omit this step if the bearings are the type that cannot be repacked.)

1. Place appropriate quantity of grease in palm of left hand
2. Grasp bearing between thumb and finger tips of the right hand with the wide or larger portion of bearing facing the left hand
3. Force grease between rollers (or balls) by pressing bearings into grease and against palm of left hand (Figure 5)

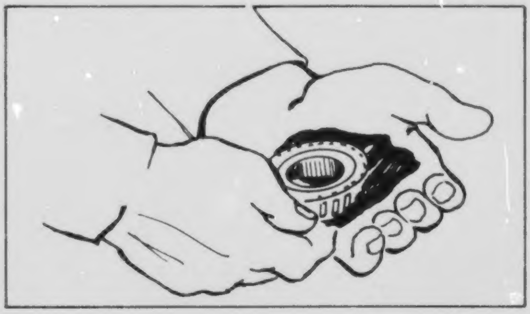


FIGURE 5

4. Draw bearing across palm of hand toward body while maintaining pressure against palm of hand
5. Repeat steps 3 and 4 until grease is forced out between roller (or ball) and cage on opposite side of bearing and the assembly is totally filled with grease
6. Coat the outside of the cage and rollers (or balls) with grease

I. Reinstall the bearings with the drift or bushing driver

J. Replace the seals

(NOTE: Use new seals if the unit is to be put back into service.)

K. Install the axle

L. Adjust bearings

1. Screw the adjusting nut or cone in until it is just snug
2. Back up the adjusting nut or cone approximately 1/4 turn and tighten the locknut to maintain correct adjustment

(NOTE: Not all bearings are adjustable.)

## WHEEL BEARINGS, AXLES, AND BALANCING
## UNIT II

### JOB SHEET #2--STATIC BALANCE A WHEEL

I. Tools and materials

   A. Motorcycle wheel complete with bearings and tire

   B. Wheel stand

   C. Assortment of balancer weights

   D. Pliers

   E. Safety glasses

II. Procedure

   A. Place wheel on wheel stand (Figure 1)

   (NOTE: It must spin freely.)

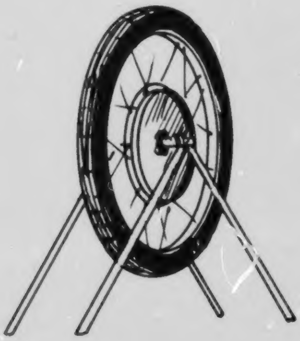


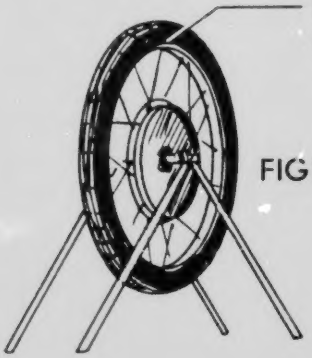
**FIGURE 1**

   B. Spin the wheel slowly and allow the wheel to stop naturally

   C. Repeat step B to be sure wheel always comes to rest at the same spot

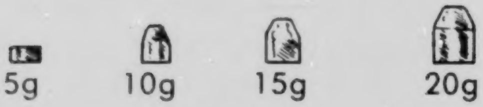
## JOB SHEET #2

D. Fasten a small weight on a spoke directly opposite the lowest point on the wheel (Figure 2)



Place wheel balance weight here

FIGURE 2



WHEEL BALANCE WEIGHT

E. Spin the wheel again

(NOTE: If the same point on the wheel stops at the top, more weight is needed. If the weight stops on the bottom, less weight is needed.)

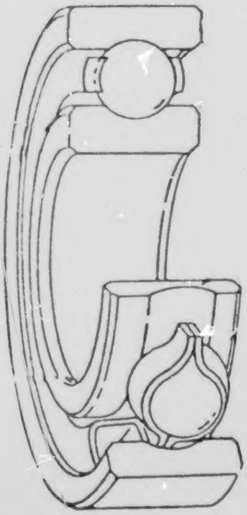
F. Repeat the spinning and adjusting of the weights until the wheel no longer stops in the same position each time it is spun

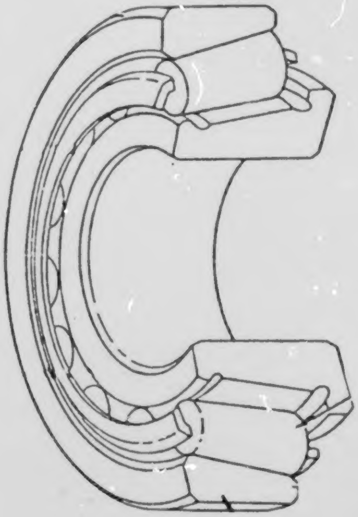
G. When the balancing is completed, fasten the weight securely

# WHEEL BEARINGS, AXLES, AND BALANCING
## UNIT II

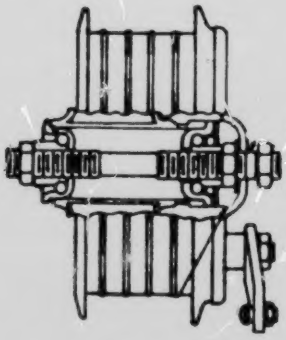
## TEST

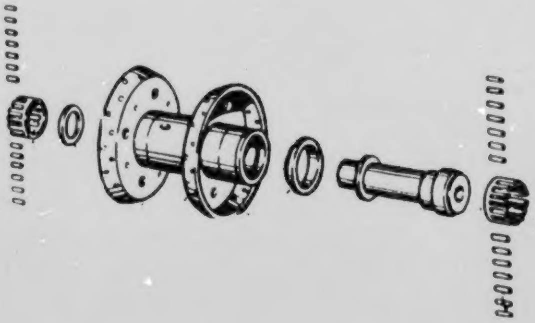
1. Identify the types of motorcycle wheel bearings.





a. ____________________ b. ____________________





c. ____________________ d. ____________________

2. Match the types of wheel bearings on the right to the correct construction characteristics.

_____a.

1) Consists of individual rollers set into a roller retainer with inner and outer races

2) Adjusted by use of shims

_____b.

1) Consists of tapered rollers set into retainer with tapered inner and outer races

2) Adjusted by movement of the inner race

_____c.

1) Consists of steel balls set into retaining cage with inner and outer races and semicircular channels for balls

2) Adjusted by means of moving threaded inner cone race

_____d.

1) Consists of steel balls with inner and outer races assembled as one piece

2) Adjustment not necessary

1. Ball cone bearing
2. Roller bearing
3. Ball bearing
4. Tapered roller bearing

3. Demonstrate the ability to:

a. Service wheel bearings and related parts.

b. Static balance a wheel.

(NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

# WHEEL BEARINGS, AXLES, AND BALANCING
## UNIT II

## ANSWERS TO TEST

1. a. Ball bearing
   b. Tapered roller bearing
   c. Ball cone bearing
   d. Roller bearing
2. a. 2
   b. 4
   c. 1
   d. 3
3. Performance skills evaluated to the satisfaction of the instructor

# FRONT FORKS AND STEERING STEM
## UNIT III

## UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms associated with front forks and steering stem to the correct definitions and identify the parts of the telescoping hydraulic forks and the steering stem. The student should also be able to describe the operation of the different front fork systems and perform common service checks and repairs on the front forks and steering stem. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with front forks and steering stem to the correct definitions.
2. Identify the parts of the telescoping hydraulic forks.
3. Identify the parts of the steering stem assembly.
4. Distinguish between a single dampening system and a double dampening system.
5. Describe the operation of the telescoping hydraulic forks on compression and rebound.
6. Describe the operation of the Earle's type fork system.
7. List the purposes of the steering damper.
8. Demonstrate the ability to:
    a. Change the hydraulic fluid in the forks.
    b. Disassemble, inspect, check, and reassemble the telescoping hydraulic fork.

# FRONT FORKS AND STEERING STEM
## UNIT III

## SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide student with objective sheet.
- B. Provide student with information and job sheets.
- C. Make transparencies.
- D. Discuss unit and specific objectives.
- E. Discuss information sheet.
- F. Demonstrate and discuss the procedures outlined in the job sheets.
- G. Give test.

II. Student:

- A. Read objective sheet.
- B. Study information sheet.
- C. Complete job sheets.
- D. Complete activities assigned by instructor.
- E. Take test.

## INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheet
- C. Transparency masters
  - 1. TM 1--Parts of Telescoping Hydraulic Fork
  - 2. TM 2--Parts of Steering Stem Assembly

3. TM 3--Telescoping Hydraulic Fork Operation
4. TM 4--Earle's (Leading Link) Type Forks

D. Job sheets

1. Job Sheet #1--Change the Hydraulic Fluid in the Forks
2. Job Sheet #2--Disassemble, Inspect, Check, and Reassemble the Telescoping Hydraulic Fork

E. Test

F. Answers to test

II. References:

A. *Honda 250-350 Service Manual*. Honda Motor Co., Ltd., 1972.

B. *Suzuki GT 550 Service Manual*. 2nd ed. Suzuki Motor Co., Ltd., 1973.

C. *Harley-Davidson Service Manual, Electra Glide 1959-1969.* Milwaukee, Wisconsin: Harley-Davidson Motor Co., 1971.

D. *Chilton's Repair and Tune-Up Guide for the BMW Motorcycle*. Radnor, Pennsylvania: Chilton Book Co., 1973.

E. *Chilton's New Motorcycle Troubleshooting Guide*. Radnor, Pennsylvania: Chilton Book Co., 1973.

# FRONT FORKS AND STEERING STEM
## UNIT III

## INFORMATION SHEET

I. Terms and definitions

   A. Telescoping hydraulic forks--Two tubes that fit together, one sliding up and down inside the other

   B. Pitch--Spacing between coils of a spring

   C. Straight wound--Spring that has equal pitch

   D. Progressive wound--Spring that has variable pitch

   E. Dampening--Suppression or control of steering vibration through the use of a restrictive device

   F. Ceriani type fork--Telescoping hydraulic fork having internal compression springs

   G. Earle's type fork system--Suspension system which has the front wheel connected to a swing arm

   (NOTE: This is also called the leading link fork system.)

II. Parts of telescoping hydraulic forks (Transparency 1)

(NOTE: While there are some minor variations, most forks consist of the same basic parts.)

   A. Fork tube or inner tube

   B. Snap ring

   C. Oil seals

   D. Fork tube guide

   E. Ring, oil seal

   F. Ring, piston stopper

   G. Ring, valve stopper

   H. Damper valve

   I. Fork tube piston

## INFORMATION SHEET

J. Fork spring

K. Boot

L. Fork slider or outer tube

M. Drain plug

N. Axle holder

III. Parts of steering stem assembly (Transparency 2)

A. Steering stem

B. Upper fork bracket

C. Handle bar clamp

D. Steering damper adjuster

E. Stem sleeve end nut

F. Damper friction disc

G. Damper friction plate

H. Damper adjusting spring

I. Damper adjusting sleeve hub

J. Steering stem bearing and spacer assembly

IV. Types of dampening systems

A. Single dampening system--Provides very little hydraulic restriction on compression stroke (10%) and a large amount of restriction on rebound stroke (90%)

B. Double dampening system--Provides almost equal restriction on both compression and rebound strokes

V. Operation of telescoping hydraulic forks (Transparency 3)

A. Compression

1. Fork tube and restricted orifice piston move downward into the slider

2. Spring is compressed which absorbs most of the shock

## INFORMATION SHEET

3. Hydraulic oil helps dampen the shock

4. Oil passes from the slider chamber below the tube, through the orifices, and into the area between the fork tube and the slider

   (NOTE: It must be understood that as the fork tube and slider telescope together, the volume capacity below the tube is decreasing, while the volume capacity between the fork tube and slider is increasing. The amount of hydraulic dampening depends upon the number and size of piston orifices, the oil viscosity, and the strength of the spring. Some forks use damper valves to restrict the flow of oil in addition to or in place of the restricted orifices.)

B. Rebound

1. Spring forces the fork tubes up to extend the fork

2. Oil in the area between the fork tube and the slider passes through the orifices, and into the slider chamber below tube

   (NOTE: The rate at which the spring can extend the fork is controlled by the rate at which the oil can return to the bottom of the slider. The rate is controlled by the design of the damper assembly. The oil nonreturn valve remains closed during the extensions of the fork and regulates oil flow. Some forks use damper valves to restrict the flow of oil in addition to, or in place of, the restricted orifices.)

VI. Operation of Earle's type fork system (Transparency 4)

(NOTE: The shock absorber provides for dampening action in the same manner as the conventional telescoping hydraulic fork system.)

A. Center line of the wheel is located in front of the shocks

B. Frame forks connect to a pivot at the rear of the swing arm

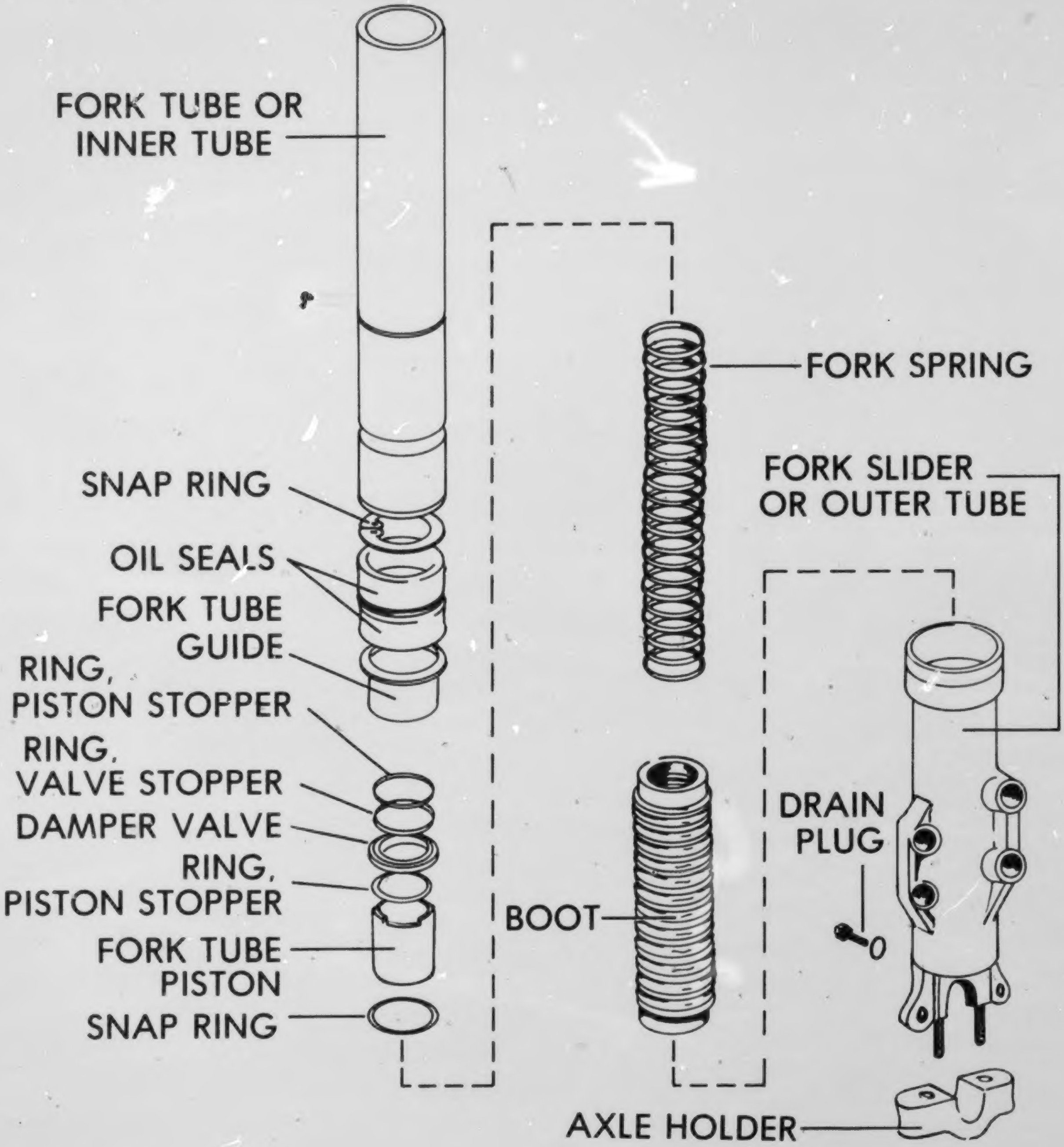
C. Swing arm moves upward and compresses shocks as the wheel rolls over rough surfaces

VII. Purposes of steering damper

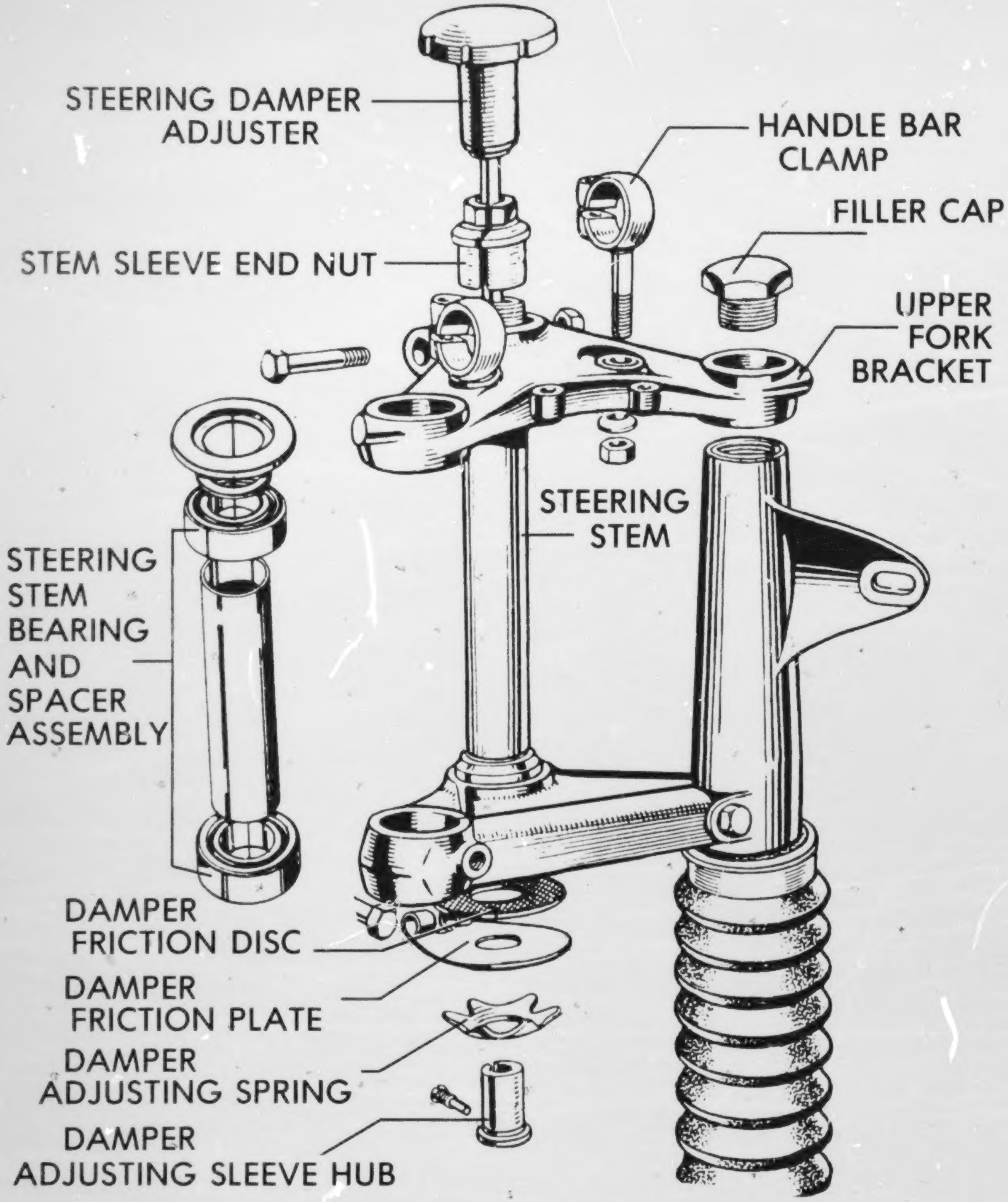
A. Provides some resistance to the turning of the steering head

B. Helps control rapid deflection of the front wheel over road irregularities

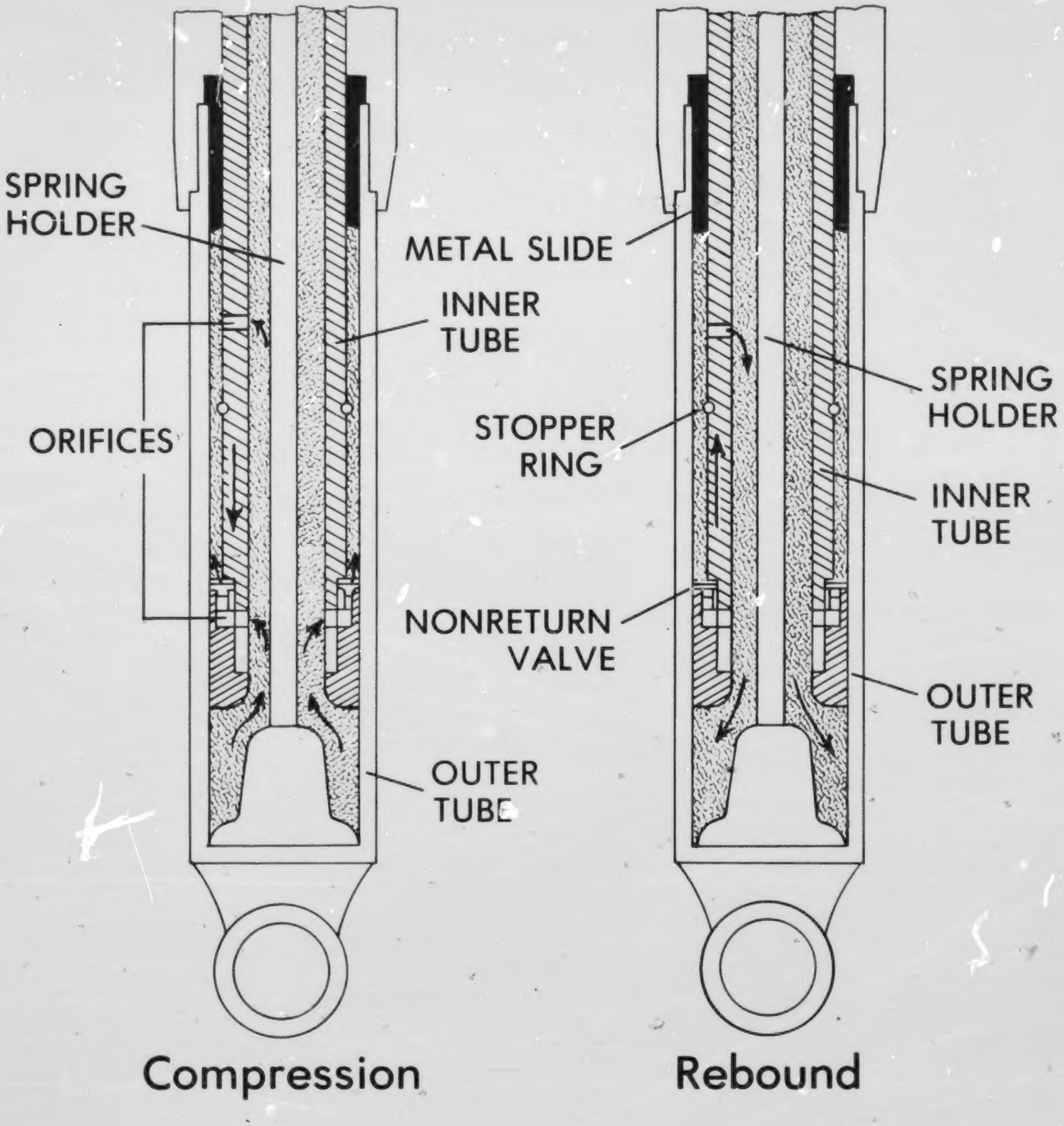
# PARTS OF TELESCOPING HYDRAULIC FORK


FORK TUBE OR INNER TUBE
SNAP RING
OIL SEALS
FORK TUBE GUIDE
RING, PISTON STOPPER
RING, VALVE STOPPER
DAMPER VALVE
RING, PISTON STOPPER
FORK TUBE PISTON
SNAP RING
FORK SPRING
FORK SLIDER OR OUTER TUBE
DRAIN PLUG
BOOT
AXLE HOLDER

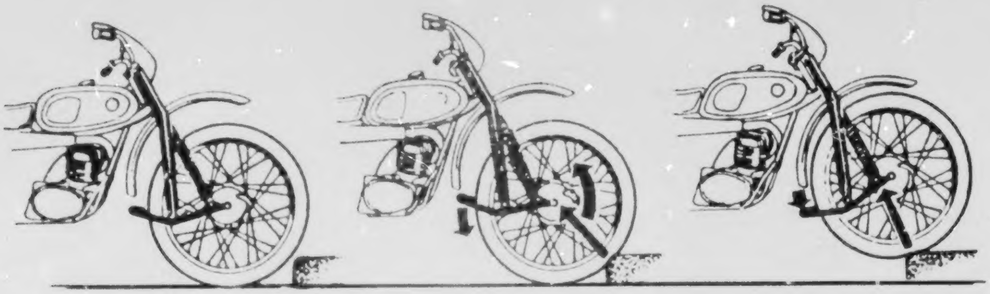
# PARTS OF STEERING STEM ASSEMBLY


STEERING DAMPER ADJUSTER
HANDLE BAR CLAMP
FILLER CAP
STEM SLEEVE END NUT
UPPER FORK BRACKET
STEERING STEM
STEERING STEM BEARING AND SPACER ASSEMBLY
DAMPER FRICTION DISC
DAMPER FRICTION PLATE
DAMPER ADJUSTING SPRING
DAMPER ADJUSTING SLEEVE HUB

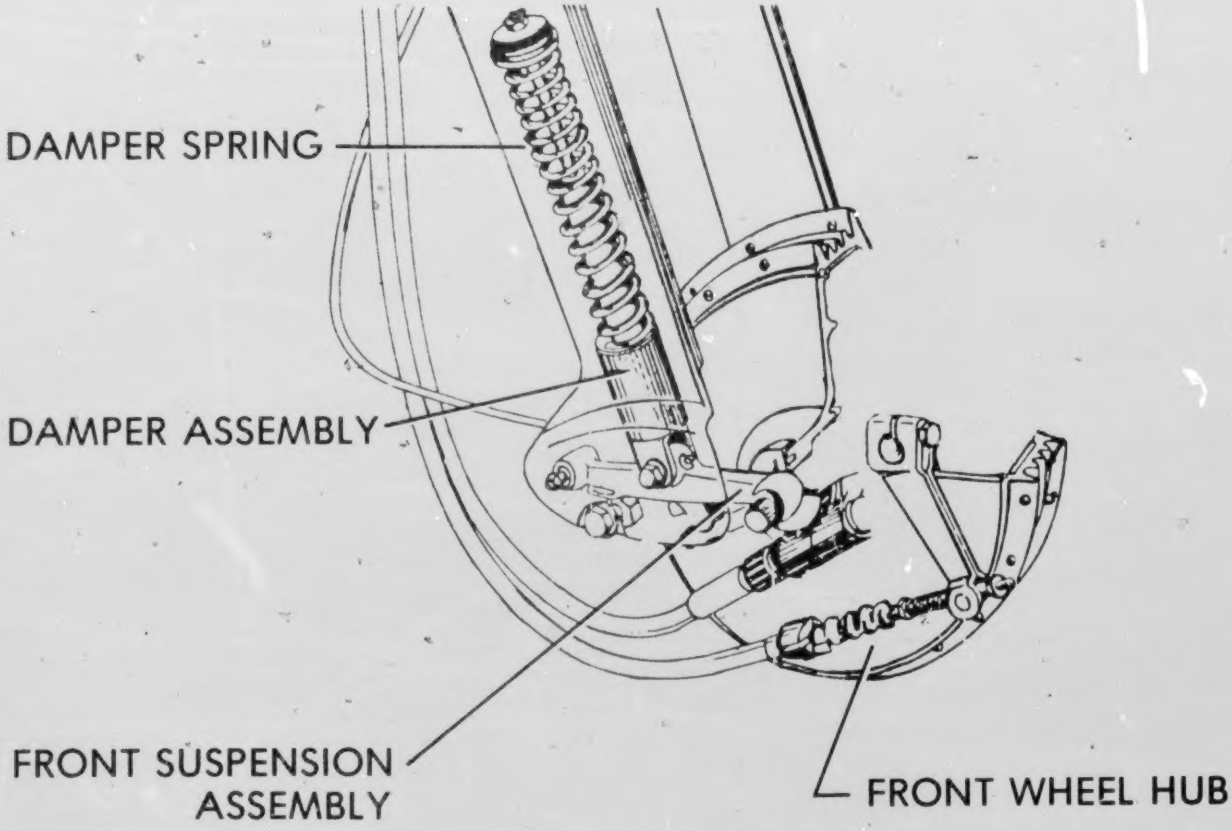
# TELESCOPING HYDRAULIC FORK OPERATION


SPRING HOLDER
METAL SLIDE
INNER TUBE
ORIFICES
STOPPER RING
SPRING HOLDER
INNER TUBE
NONRETURN VALVE
OUTER TUBE
OUTER TUBE
Compression
Rebound

# EARLE'S (LEADING LINK) TYPE FORKS



Earle's type forks pivot over obstacles


DAMPER SPRING
DAMPER ASSEMBLY
FRONT SUSPENSION ASSEMBLY
FRONT WHEEL HUB

# FRONT FORKS AND STEERING STEM
## UNIT III

## JOB SHEET #1--CHANGE THE HYDRAULIC FLUID IN THE FORKS

I. Tools and materials

- A. Hand tool assortment
- B. Metric wrench set or large adjustable wrench
- C. Drain pan
- D. Measuring container
- E. Replacement oil specified by manufacturer
- F. Appropriate service manual
- G. Safety glasses

II. Procedure

- A. Remove filler caps at top of forks
- B. Place the drain pan under the fork and remove the drain plug
- C. Apply the front brake and pump the forks to remove all old oil
- D. Replace drain plug
- E. Following the manufacturer's specifications, measure out the correct quantity of oil
- F. Pour the oil into the top of the fork, and replace the filler cap

# FRONT FORKS AND STEERING STEM
## UNIT III

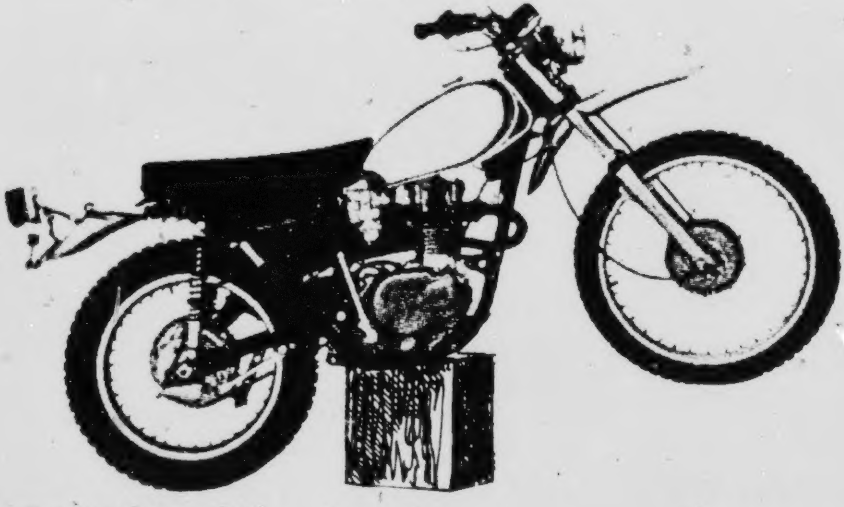
## JOB SHEET #2 DISASSEMBLE, INSPECT, CHECK, AND REASSEMBLE THE TELESCOPING HYDRAULIC FORK

I. Tools and materials

- A. Metric wrench set
- B. Hand tool assortment
- C. Wood blocks or motorcycle stand
- D. Vernier caliper
- E. Micrometer
- F. Cylinder gauge
- G. Seal driver
- H. Drain pan
- I. Appropriate service manual
- J. Replacement oil specified by manufacturer
- K. Safety glasses

II. Procedure

- A. Block up motorcycle using wood blocks (Figure 1)



- B. Remove front wheel

## JOB SHEET #2

C. Remove the bolts that clamp the forks to the steering stem and upper fork bracket

D. Disconnect or remove any other parts as necessary

E. Remove front forks

F. Remove drain plug, and drain oil into drain pan

G. Remove dust boot or shield and the internal snap ring (Figure 2)

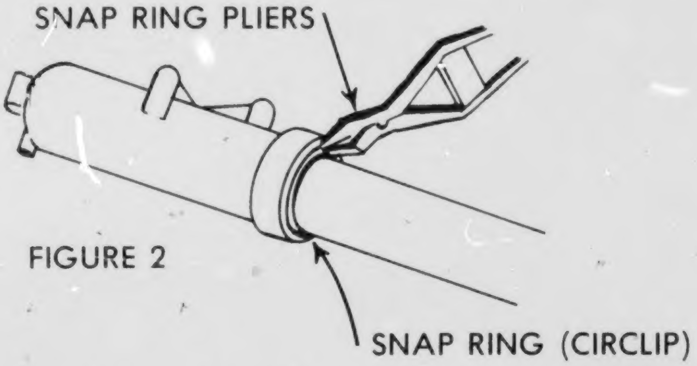

SNAP RING PLIERS
SNAP RING (CIRCLIP)

FIGURE 2

H. Pull the fork tube out of the slider

(NOTE: Often the seal and fork tube guide must be pulled at the same time. Some force is required to separate the fork tube and slider.)

I. Inspect and measure the parts of the front fork

1. Fork spring (Figures 3 and 4)

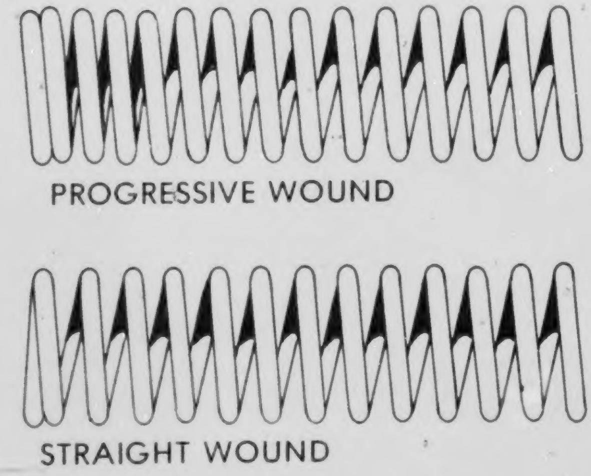

PROGRESSIVE WOUND
STRAIGHT WOUND

FIGURE 3

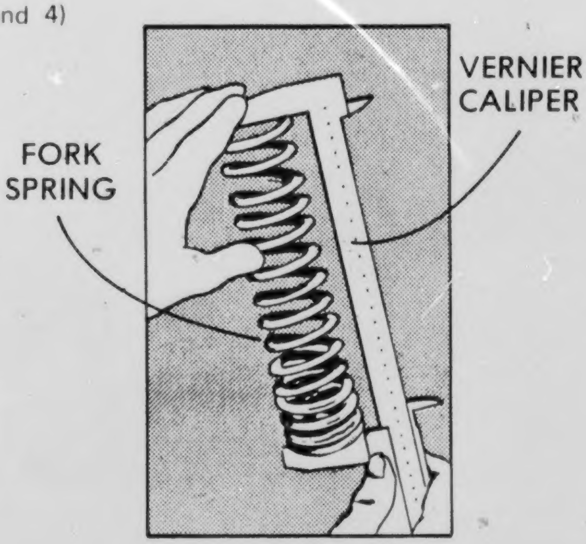

VERNIER CALIPER
FORK SPRING

FIGURE 4

JOB SHEET #2

2. Fork piston (Figure 5)

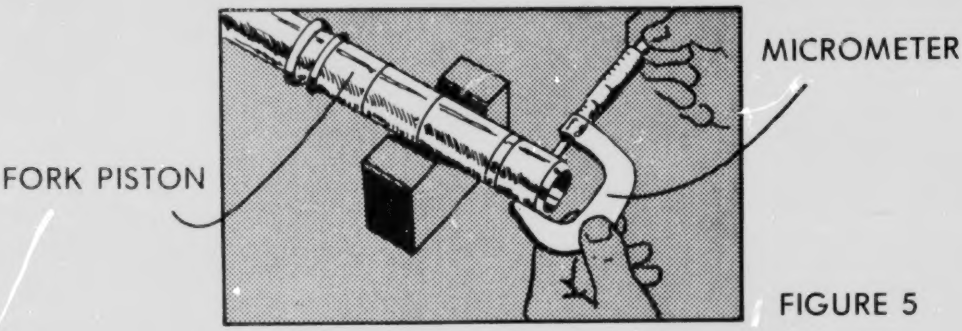

MICROMETER
FORK PISTON

FIGURE 5

3. Fork slider (Figure 6)

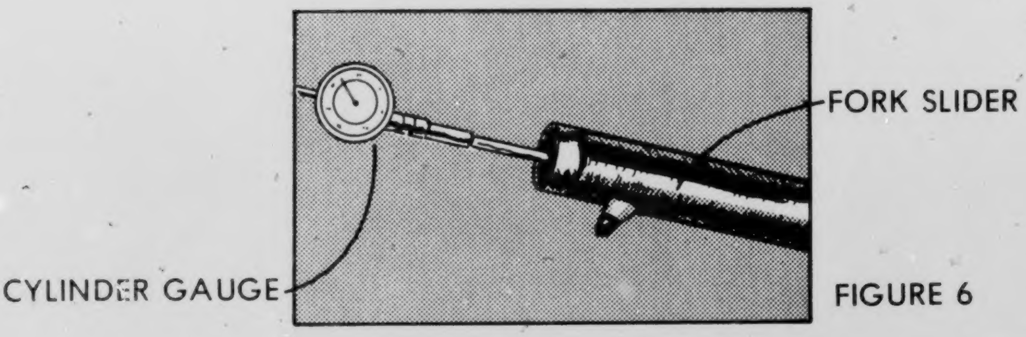

FORK SLIDER
CYLINDER GAUGE

FIGURE 6

J. Check fork tube alignment (Figure 7)

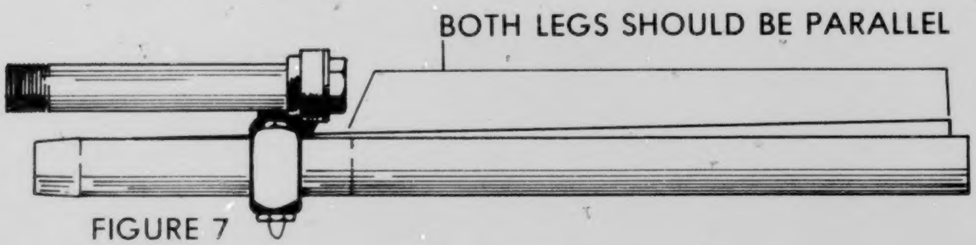

BOTH LEGS SHOULD BE PARALLEL

FIGURE 7

K. Put the fork tubes back into the steering stem brackets and check the tubes for parallelism

## JOB SHEET #2

L. Reassemble the forks using new seals (Figure 8)

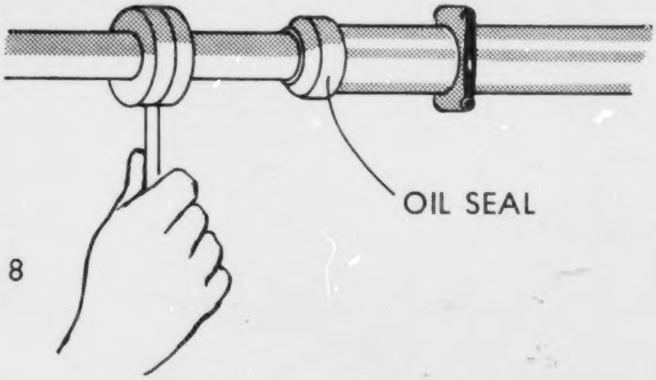


FIGURE 8

M. Install the fork assemblies and fill with the correct type and quantity of oil (Figure 9)

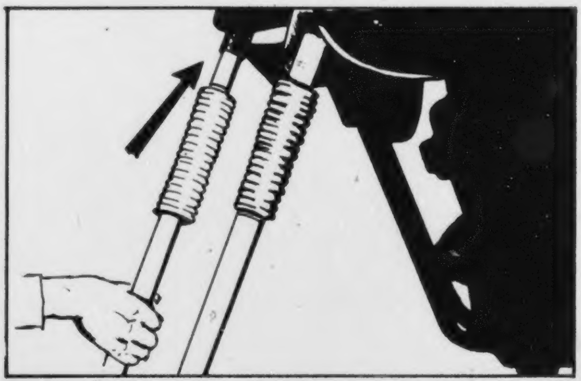


FIGURE 9

N. Replace the rest of the components by reversing procedures B through D

O. Remove cycle from wood blocks or motorcycle stand

# FRONT FORKS AND STEERING STEM
## UNIT III

## TEST

1. Match the terms on the right to the correct definitions.

_____a. Suspension system which has the front wheel connected to a swing arm

_____b. Spring that has variable pitch

_____c. Telescoping hydraulic fork having internal compression springs

_____d. Spacing between coils of a spring

_____e. Suppression or control of steering vibration through the use of a restrictive device

_____f. Two tubes that fit together, one sliding up and down inside the other

_____g. Spring that has equal pitch

1. Pitch
2. Ceriani type fork
3. Dampening
4. Telescoping hydraulic forks
5. Straight wound
6. Earle's type fork system
7. Progressive wound

2. Identify the parts of the telescoping hydraulic forks.

a.

b.

c.

d.

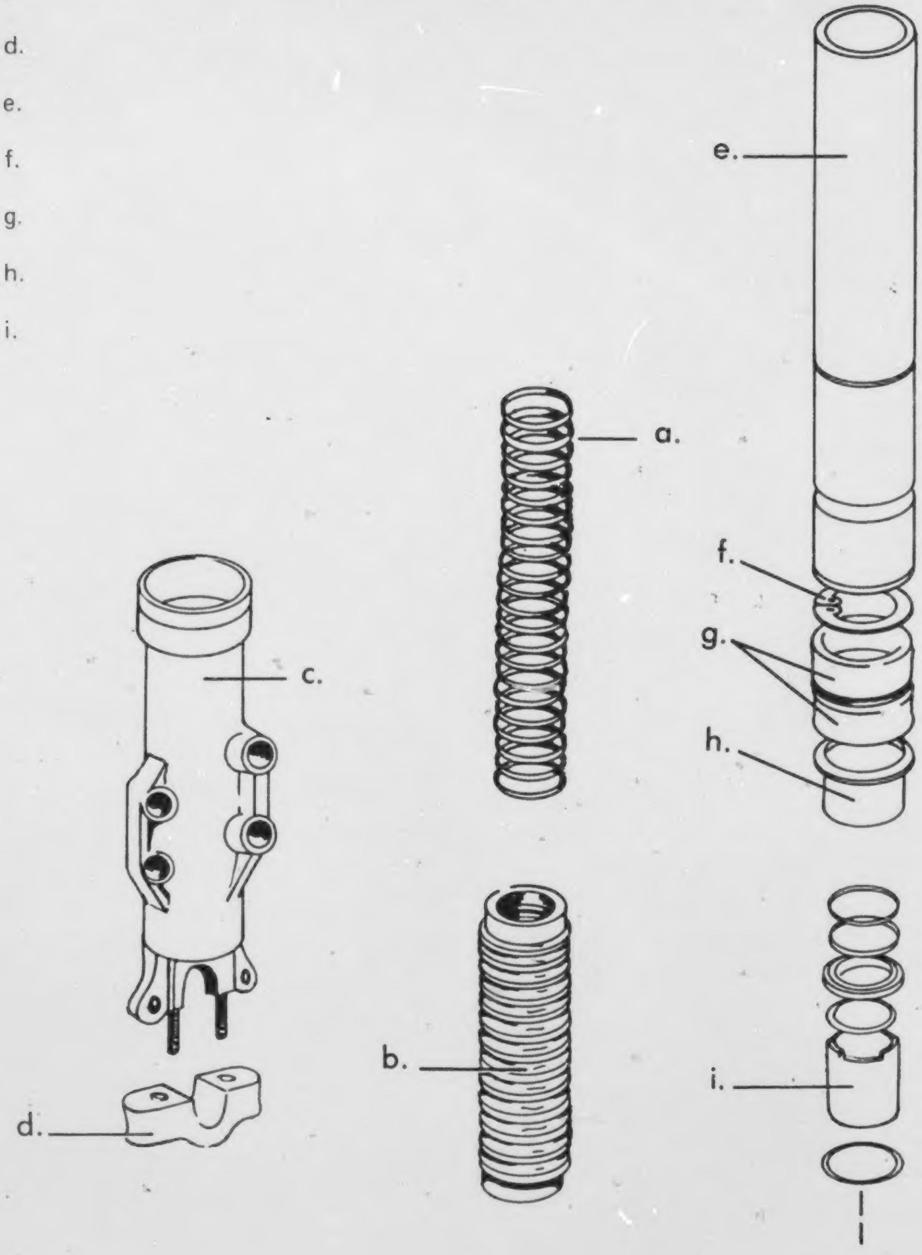
e.

f.

g.

h.

i.



3. Identify the parts of the steering stem assembly.

a.

b.

c.

d.

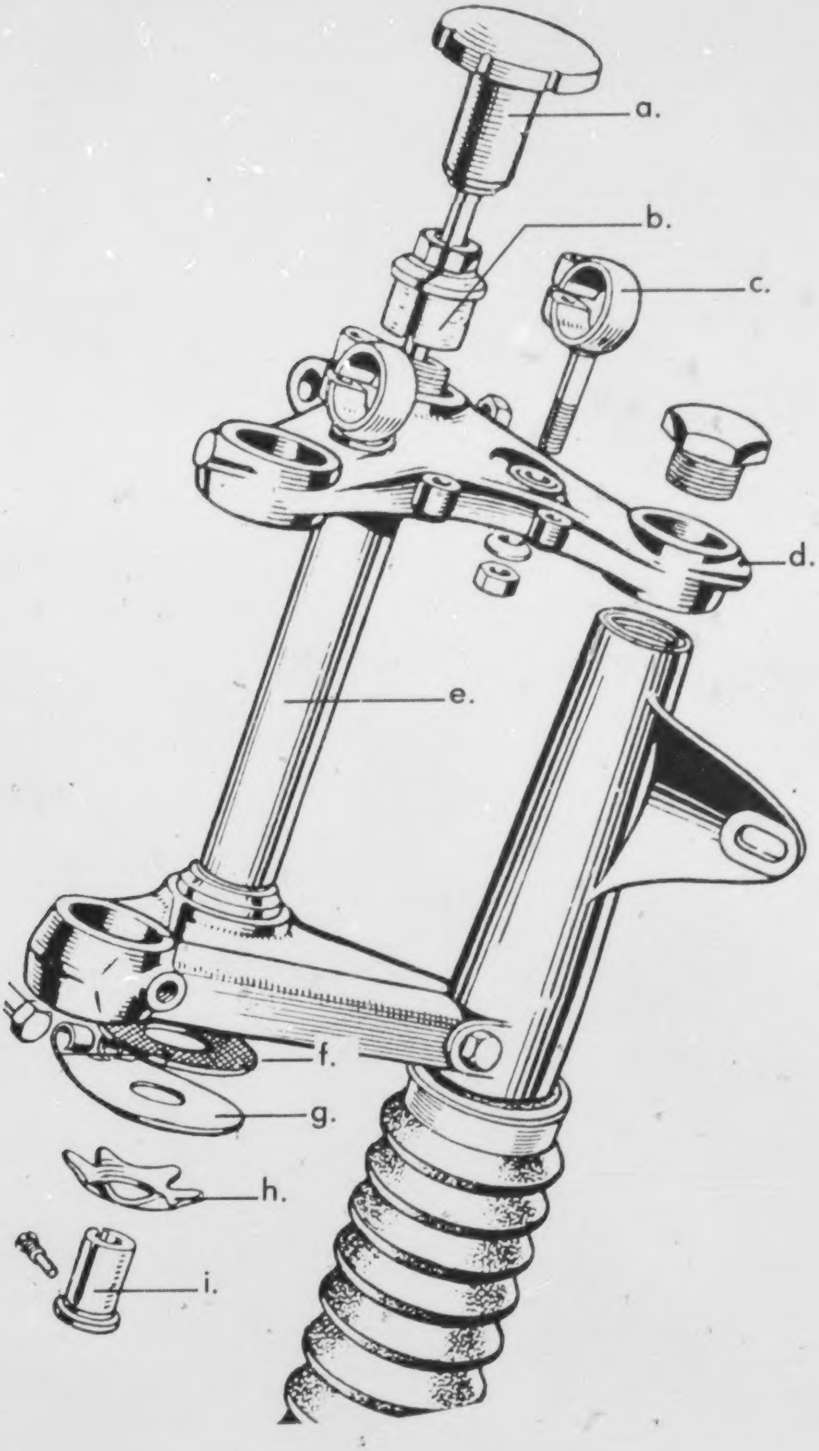
e.

f.

g.

h.

i.

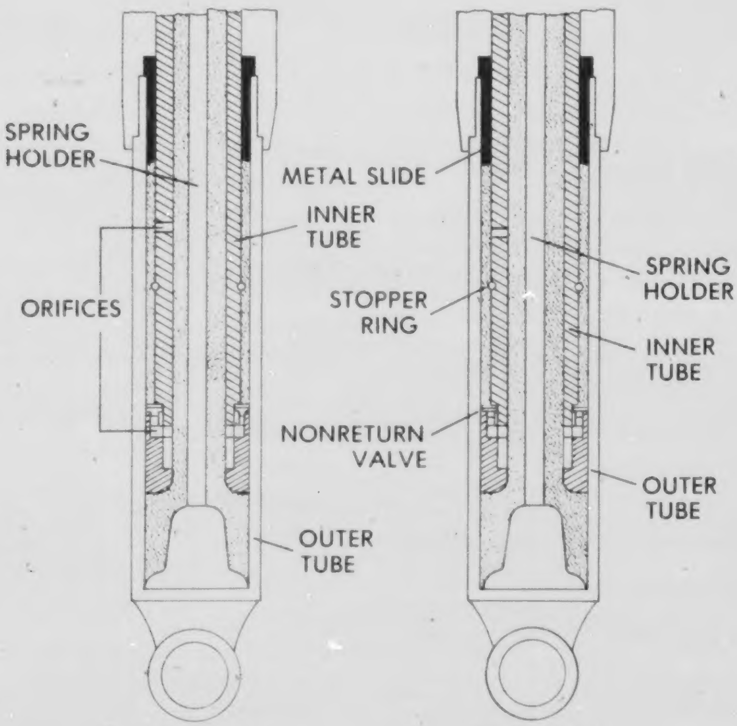


4. Distinguish between a single dampening system and a double dampening system by placing an "X" next to the description of the single dampening system.

   _____a. Provides almost equal restriction on both compression and rebound strokes

   _____b. Provides very little hydraulic restriction on compression stroke (10%) and a large amount of restriction on rebound stroke (90%)

5. Describe the operation of the telescoping hydraulic fork in the illustration on compression and rebound.


SPRING HOLDER
ORIFICES
INNER TUBE
OUTER TUBE
METAL SLIDE
STOPPER RING
NONRETURN VALVE
SPRING HOLDER
INNER TUBE
OUTER TUBE

Compression

Rebound

a. Compression

b. Rebound

6. Describe the operation of the Earle's type fork system.

7. List the purposes of the steering damper.

   a.

   b.

8. Demonstrate the ability to:

   a. Change the hydraulic fluid in the forks.

   b. Disassemble, inspect, check, and reassemble the telescoping hydraulic fork.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

## FRONT FORKS AND STEERING STEM
## UNIT III

### ANSWERS TO TEST

1. a. 6
   b. 7
   c. 2
   d. 1
   e. 3
   f. 4
   g. 5
2. a. Fork spring
   b. Boot
   c. Fork slider or outer tube
   d. Axle holder
   e. Fork tube or inner tube
   f. Snap ring
   g. Oil seals
   h. Fork tube guide
   i. Fork tube piston
3. a. Steering damper adjuster
   b. Handle bar clamp
   c. Stem sleeve end nut
   d. Upper fork bracket
   e. Steering stem
   f. Damper friction disc
   g. Damper friction plate
   h. Damper adjusting spring
   i. Damper adjusting sleeve hub
4. b

5. Description should include:

   a. Compression

      1) Fork tube and restricted orifice piston move downward into the slider

      2) Spring is compressed which absorbs most of the shock

      3) Hydraulic oil helps dampen the shock

      4) Oil passes from the slider chamber below the tube, through the orifice, and into the area between the fork tube and the slider

   b. Rebound

      1) Spring forces the fork tubes up to extend the fork

      2) Oil in the area between the fork tube and the slider passes through the orifices, and into the slider chamber below tube

6. Description should include:

   a. Center line of the wheel is located in front of the shocks

   b. Frame forks connect to a pivot at the rear of the swing arm

   c. Swing arm moves upward and compresses shocks as the wheel rolls over rough surfaces

7. a. Provides some resistance to the turning of the steering head

   b. Helps control rapid deflection of the front wheel over road irregularities

8. Performance skills evaluated to the satisfaction of the instructor

# REAR SWING ARM AND SHOCKS
## UNIT IV

## UNIT OBJECTIVE

After completion of this unit, the student should be able to list the major components of the rear suspension system and identify the parts of the rear swing arm assembly and the shock absorber assembly. The student should also be able to describe the operation of the rear suspension system and demonstrate the ability to check, adjust, and service the rear suspension system. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. List the four major components of the rear suspension system.
2. Identify the parts of the rear swing arm assembly.
3. Identify the parts of the shock absorber assembly.
4. Describe the operation of the rear swing arm suspension system on compression and rebound.
5. Discuss rear shock absorber spring tension adjustment.
6. Demonstrate the ability to:
    a. Check and adjust rear shock absorbers.
    b. Remove, check, service, and install rear swing arm assembly.

# REAR SWING ARM AND SHOCKS
## UNIT IV

## SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss the procedures outlined in the job sheets.

  G. Demonstrate and discuss a cutaway of an old shock absorber.

  H. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Complete job sheets.

  D. Take test.

## INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Major Components of Rear Suspension System

    2. TM 2--Parts of Rear Swing Arm Assembly

    3. TM 3--Parts of Shock Absorber Assembly

4. TM 4--Oil Flow Within Rear Shock Absorber

5. TM 5--Rear Shock Absorber Spring Tension Adjustment

D. Job sheets

1. Job Sheet #1--Check and Adjust Rear Shock Absorbers

2. Job Sheet #2--Remove, Check, Service, and Install Rear Swing Arm Assembly

E. Test

F. Answers to test

II. References:

A. Nicholson, J. B. *Modern Motorcycle Mechanics.* 7th ed. Saskatoon, Saskatchewan, Canada: Nicholson Brothers Motorcycles, Ltd., 1974.

B. *Honda 250-350 Service Manual.* Honda Motor Co., Ltd., 1972.

C. *Chilton's New Motorcycle Troubleshooting Guide.* Radnor, Pennsylvania: Chilton Book Co., 1973.

D. *Harley-Davidson Service Manual, Electra Glide 1959-1969.* Milwaukee, Wisconsin: Harley-Davidson Motor Co., 1971.

E. *BSA 350 Service Manual.* Norton Triumph Corp., 1973.

# REAR SWING ARM AND SHOCKS
# UNIT IV

## INFORMATION SHEET

I. Major components of rear suspension system (Transparency 1)

   A. Swing arm

   B. Hydraulic shock absorber

   C. Spring

   D. Pivot bolt or shaft

II. Parts of rear swing arm assembly (Transparency 2)

   A. Swing arm

   B. Pivot shaft

   C. Short spacer

   D. Bushings or bearings

   E. Seals

   F. End caps

   G. Long spacer

   (NOTE: There are two types of swing arm assemblies, bushing and needle bearing.)

III. Parts of shock absorber assembly (Transparency 3)

   A. Top cover

   B. Rubber bumper

   C. Rubber mounting bushings

   D. Shock absorber

   E. Spring cover

   F. Spring

   G. Spacer washer

## INFORMATION SHEET

H. Seal washer

I. Cam sleeve

J. Upper adjusting cam

K. Lower adjusting cam

L. Roll pin

M. Cam support

(NOTE: The shock absorber assembly in TM-3 is a Harley-Davidson Electra Glide, and it contains a few more parts than the typical import. The major parts and design features are similar on all shock absorber assemblies.)

IV. Operation of rear swing arm suspension system (Transparency 4)

A. Compression

1. Over an irregularity in road surface, wheel moves upward causing rear swing arm to move upward

2. Swing arm movement is restricted by

a. Spring

b. Oil within shock absorber

1) Oil forced from one part of shock to another

2) Oil flow controlled by restricting valves or ports

3. Swing arm and shocks allow

a. Rear wheel to move upward in reaction to road irregularity

b. Frame and rider to receive only small portion of this movement

B. Rebound

1. Spring pushes shock and swing arm back down

2. Swing arm carries wheel down to regain contact with road surface

## INFORMATION SHEET

3. Swing arm movement again restricted by oil within shock absorber
    a. Oil is forced from one part of shock to another
    b. Oil flow controlled by restricting valves or ports

V. Rear shock absorber spring tension adjustment (Transparency 5)
  A. Spring tension adjusted to compensate for load and road variations
  B. Spring tension adjusted by rotating cam device
    1. Low position for light loads
    2. Middle position for double riding
    3. High position for extra heavy loads

(NOTE: Always use same setting on both shocks.)

# MAJOR COMPONENTS OF REAR SUSPENSION SYSTEM

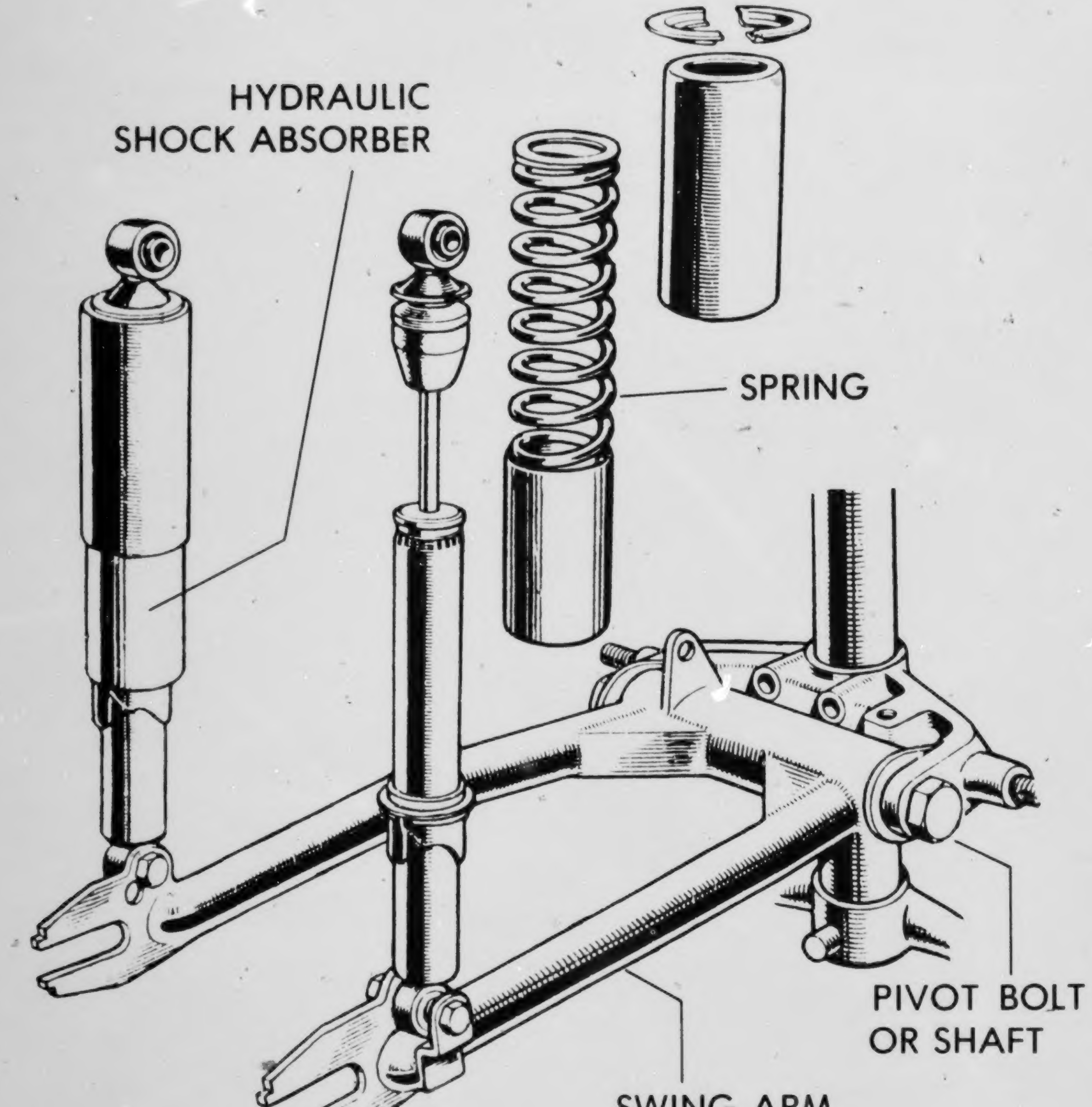
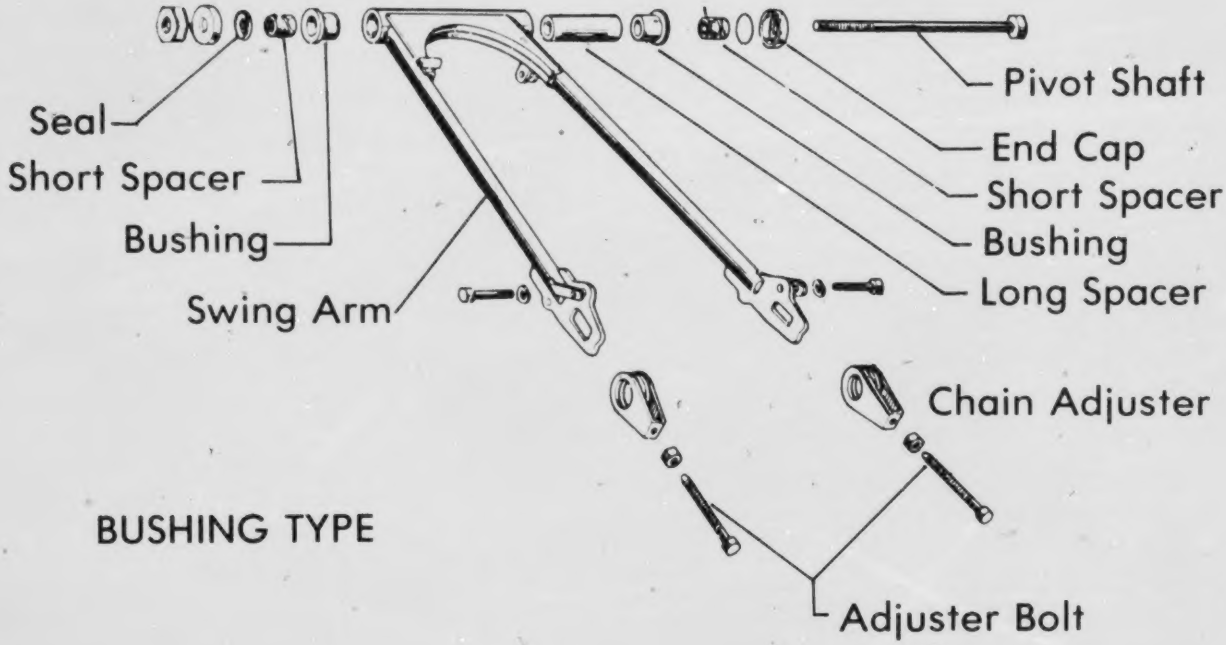
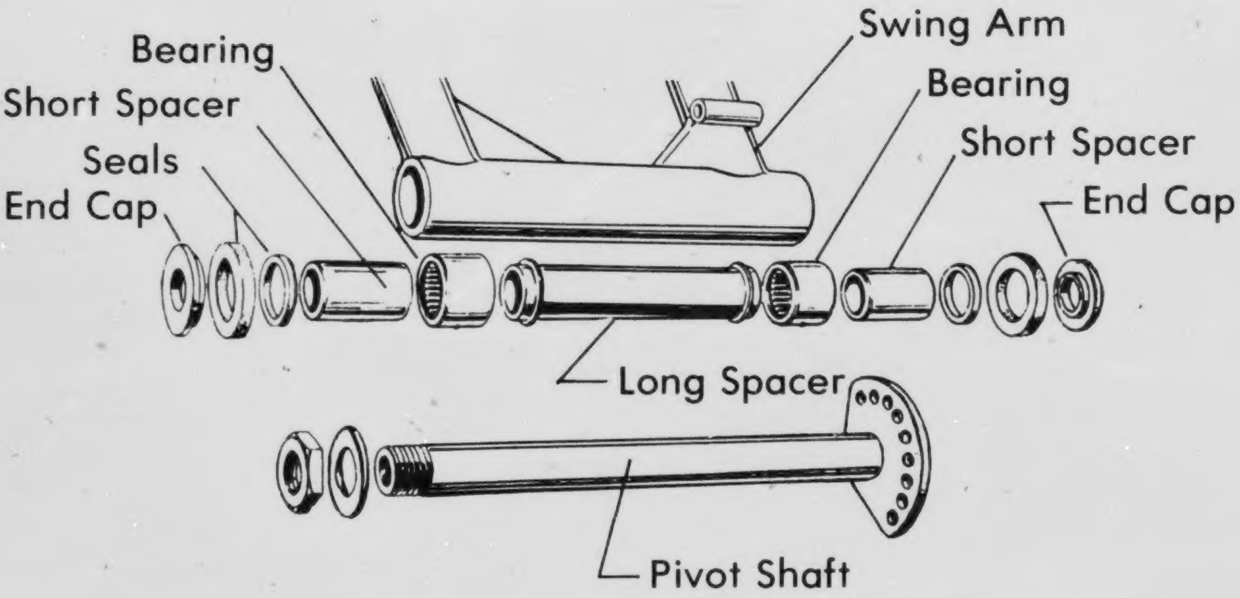

HYDRAULIC SHOCK ABSORBER
SPRING
PIVOT BOLT OR SHAFT
SWING ARM

Illustration by Norton-Triumph Corporation

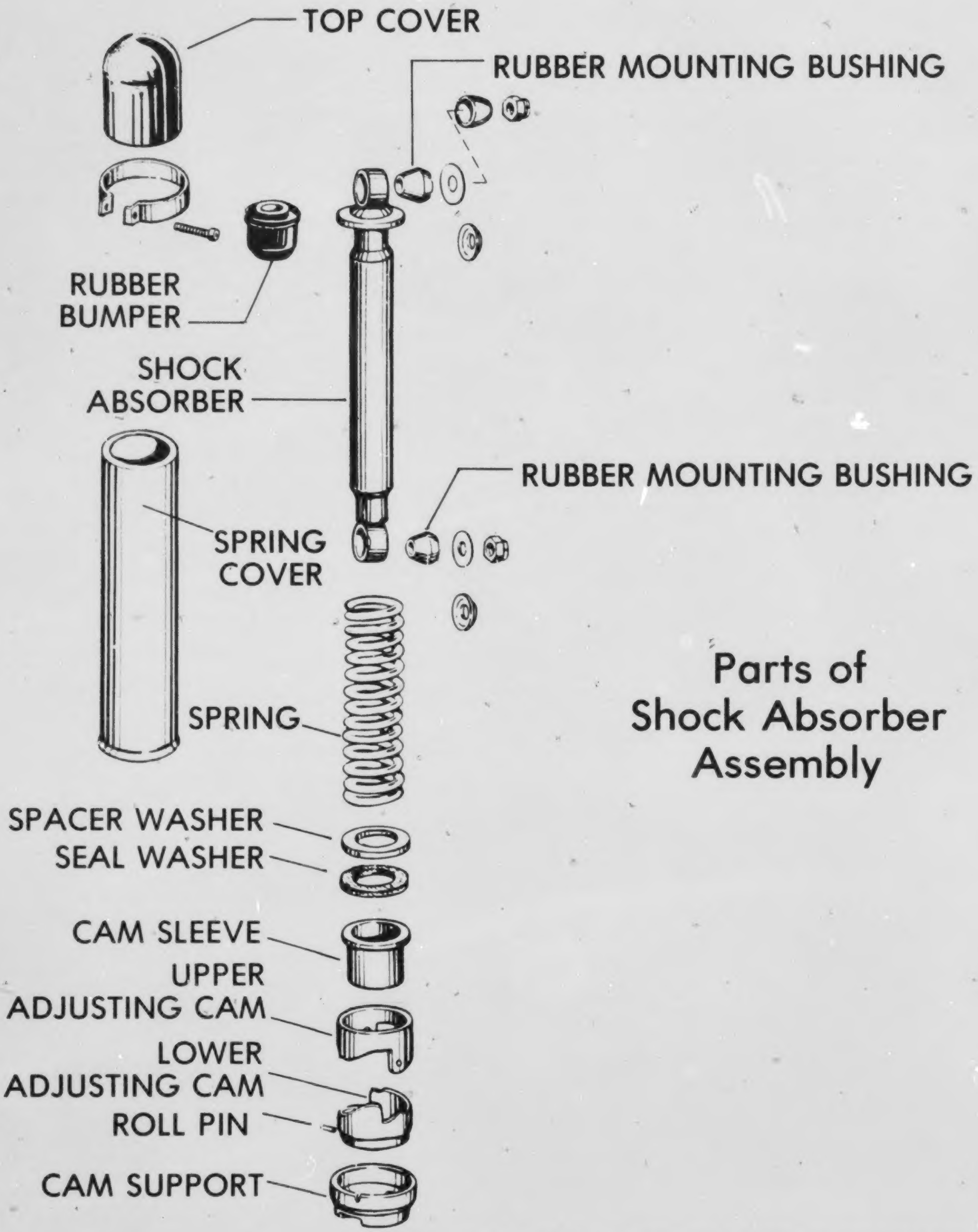
# PARTS OF REAR SWING ARM ASSEMBLY


Pivot Shaft
Seal
End Cap
Short Spacer
Short Spacer
Bushing
Bushing
Long Spacer
Swing Arm
Chain Adjuster
Adjuster Bolt

BUSHING TYPE

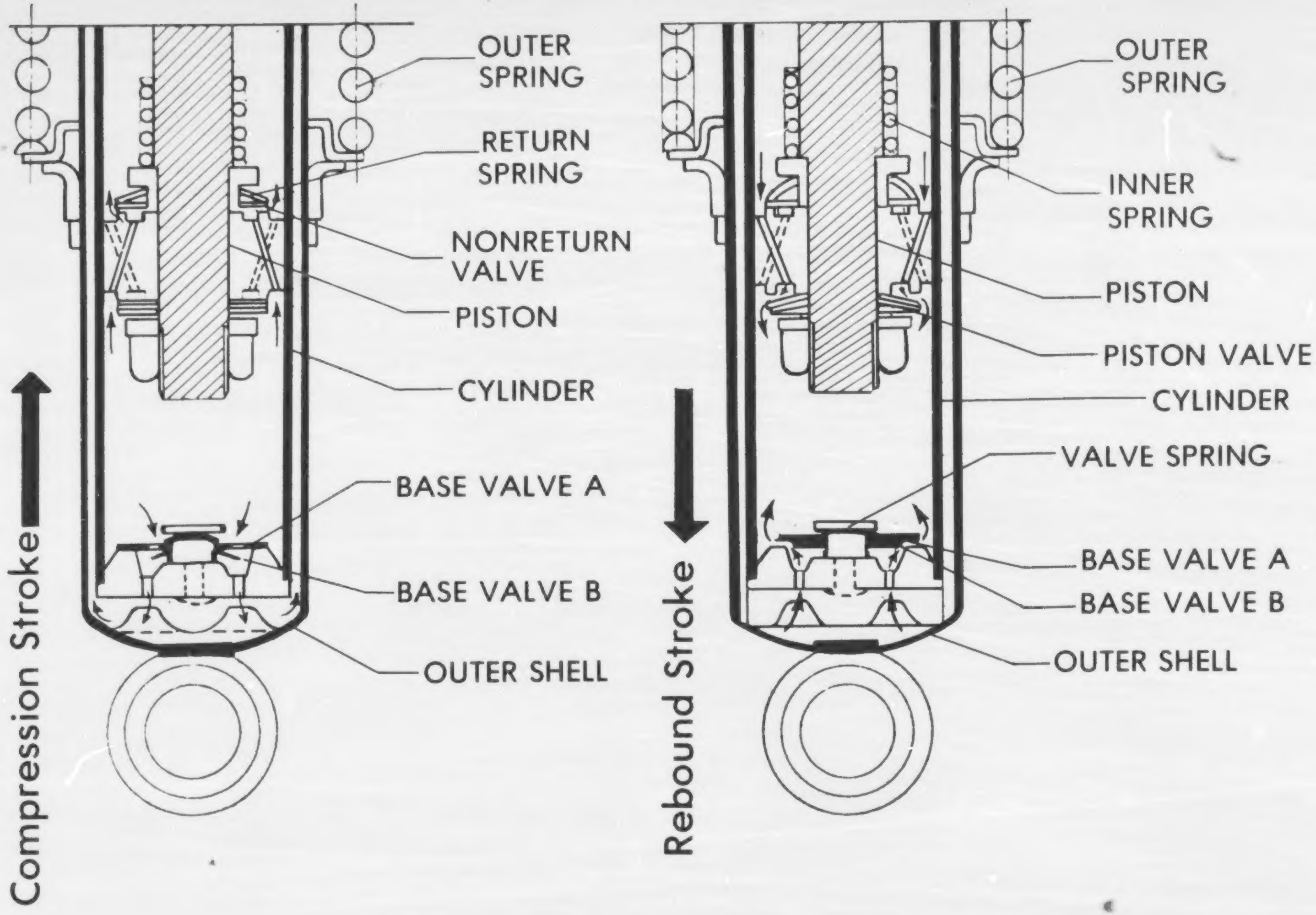

Swing Arm
Bearing
Bearing
Short Spacer
Short Spacer
Seals
End Cap
End Cap
Long Spacer
Pivot Shaft

NEEDLE BEARING TYPE


TOP COVER
RUBBER MOUNTING BUSHING
RUBBER BUMPER
SHOCK ABSORBER
RUBBER MOUNTING BUSHING
SPRING COVER
SPRING
SPACER WASHER
SEAL WASHER
CAM SLEEVE
UPPER ADJUSTING CAM
LOWER ADJUSTING CAM
ROLL PIN
CAM SUPPORT

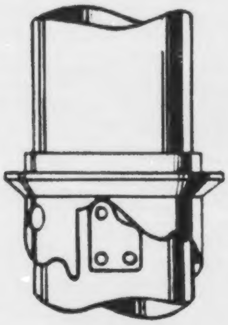
Parts of
Shock Absorber
Assembly

# OIL FLOW WITHIN REAR SHOCK ABSORBER


OUTER SPRING
RETURN SPRING
NONRETURN VALVE
PISTON
CYLINDER
BASE VALVE A
BASE VALVE B
OUTER SHELL
Compression Stroke
Rebound Stroke
OUTER SPRING
INNER SPRING
PISTON
PISTON VALVE
CYLINDER
VALVE SPRING
BASE VALVE A
BASE VALVE B
OUTER SHELL

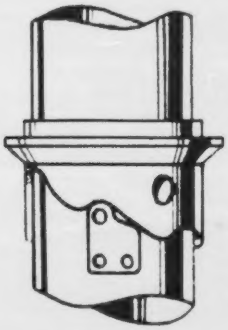
# REAR SHOCK ABSORBER SPRING TENSION ADJUSTMENT

LOW POSITION



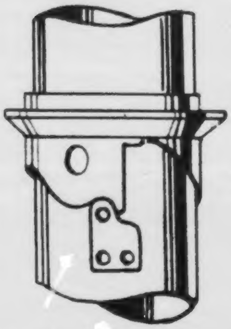
LIGHT LOADS

MIDDLE POSITION



DOUBLE RIDING

HIGH POSITION



EXTRA HEAVY LOADS

ILLUSTRATION COURTESY OF
NORTON TRIUMPH CORPORATION

# REAR SWING ARM AND SHOCKS
# UNIT IV

## JOB SHEET #1--CHECK AND ADJUST REAR SHOCK ABSORBERS

I. Tools and materials

- A. Hand tool assortment
- B. Metric wrenches
- C. Shock absorber compressor or hydraulic press
- D. Vernier caliper or suitable measuring instrument
- E. Appropriate service manual
- F. Safety glasses

II. Procedure

- A. Remove shock absorber from the motorcycle by removing the upper and lower retaining bolts (Figure 1)

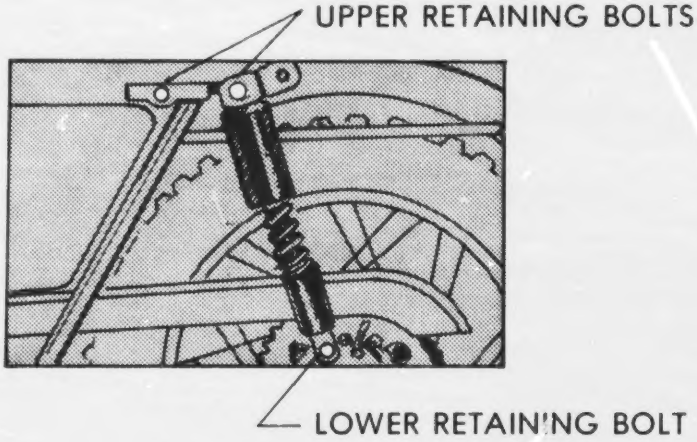


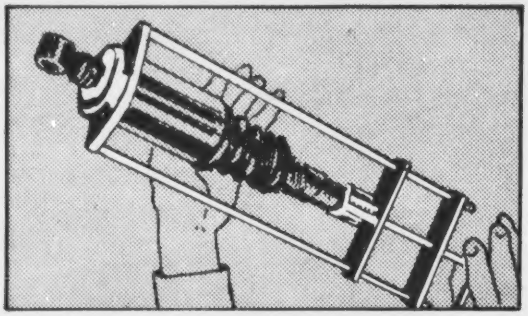
Figure 1

## JOB SHEET #1

B. Compress the shock absorber spring until the springs retainers can be removed (Figure 2)

(NOTE: Use the spring compressing device suggested in the appropriate service manual.)

Figure 2



C. Release spring tension and remove the spring and other parts from the shock

D. Inspect the hydraulic shock absorber for:

1. Oil leakage
2. Damage

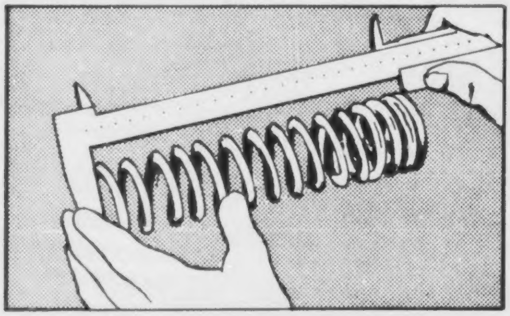
E. Check the resistance to compression and extension of the shock

(NOTE: Shock should compress considerably easier than it extends.)

F. Measure the cushion spring for: (Figure 3)

1. Free length
2. Squareness

Figure 3



## JOB SHEET #1

G. Reassemble the shock absorber using the compressor or hydraulic press and lock in place with spring retainers

H. Reinstall the shock absorber

I. Adjust the shock absorber to service manual specifications

## REAR SWING ARM AND SHOCKS
## UNIT IV

### JOB SHEET #2--REMOVE, CHECK, SERVICE, AND INSTALL REAR SWING ARM ASSEMBLY

I. Tools and materials

A. Hand tool assortment

B. Metric end wrench set

C. Metric socket set

D. Drift punch

E. V-blocks

F. Dial indicator

G. Surface plate or suitable flat, true surface

H. Multipurpose grease

I. Appropriate service manual

J. Motorcycle stand or wood blocks

K. Safety glasses

II. Procedure

A. Block up the motorcycle so rear wheel is raised off the floor

B. Unfasten the shock absorber lower mounts from the swing arm

C. Disconnect the drive chain

D. Disconnect the rear brake rod

E. Remove rear wheel axle and wheel

F. Remove pivot shaft nut and withdraw the pivot shaft

(NOTE: Often a hammer and drift punch are needed to drive the pivot shaft out.)

G. Separate rear swing arm from the frame

H. Drive or press out all bushings, bearings, seals, and spacers from the swing arm

## JOB SHEET #2

I. Inspect the following for wear:

1. Bearings and bushings
2. Pivot shaft
3. Swing arm

J. Mount swing arm in V-blocks and position on surface plate (Figure 1)

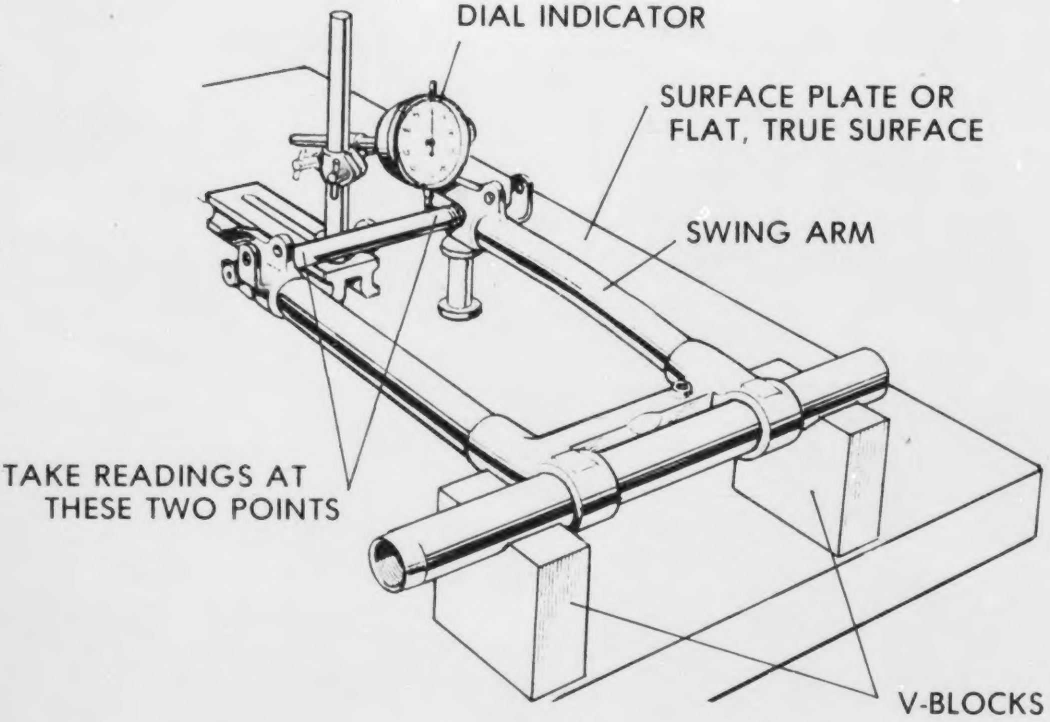

DIAL INDICATOR
SURFACE PLATE OR FLAT, TRUE SURFACE
SWING ARM
TAKE READINGS AT THESE TWO POINTS
V-BLOCKS

Figure 1

K. Check the rear swing arm for alignment by mounting dial indicator on surface plate and take a reading at both sides of the swing arm (Figure 1)

(NOTE: A difference in readings will indicate a bent or sprung swing arm. Consult the appropriate service manual for manufacturer's recommendations as to straightening or replacing damaged swing arm.)

# JOB SHEET #2

L. Reassemble the bushings or bearings, spacers, and seals in the swing arm

(NOTE: Be sure to lubricate the bushings or bearings with multipurpose grease.)

M. Replace the swing arm on the frame, installing the pivot shaft and securing with nut and washer

N. Replace wheel on swing arm

O. Install shock absorbers

P. Install chain

Q. Connect brake rod

R. Adjust drive chain for proper tension and alignment before tightening rear axle

# REAR SWING ARM AND SHOCKS
## UNIT IV

## TEST

1. List the four major components of the rear suspension system.

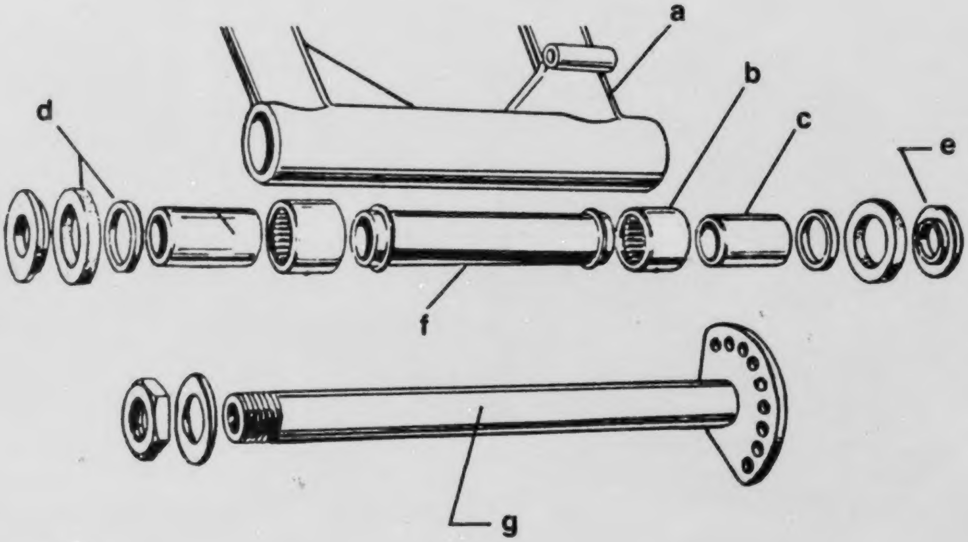
   a.

   b.

   c.

   d.

2. Identify the parts of the rear swing arm assembly.



a. ____________ e. ____________

b. ____________ f. ____________

c. ____________ g. ____________

d. ____________

3. Identify the parts of the shock absorber assembly.

a. ______________________

b. ______________________

c. ______________________

d. ______________________

e. ______________________

f. ______________________

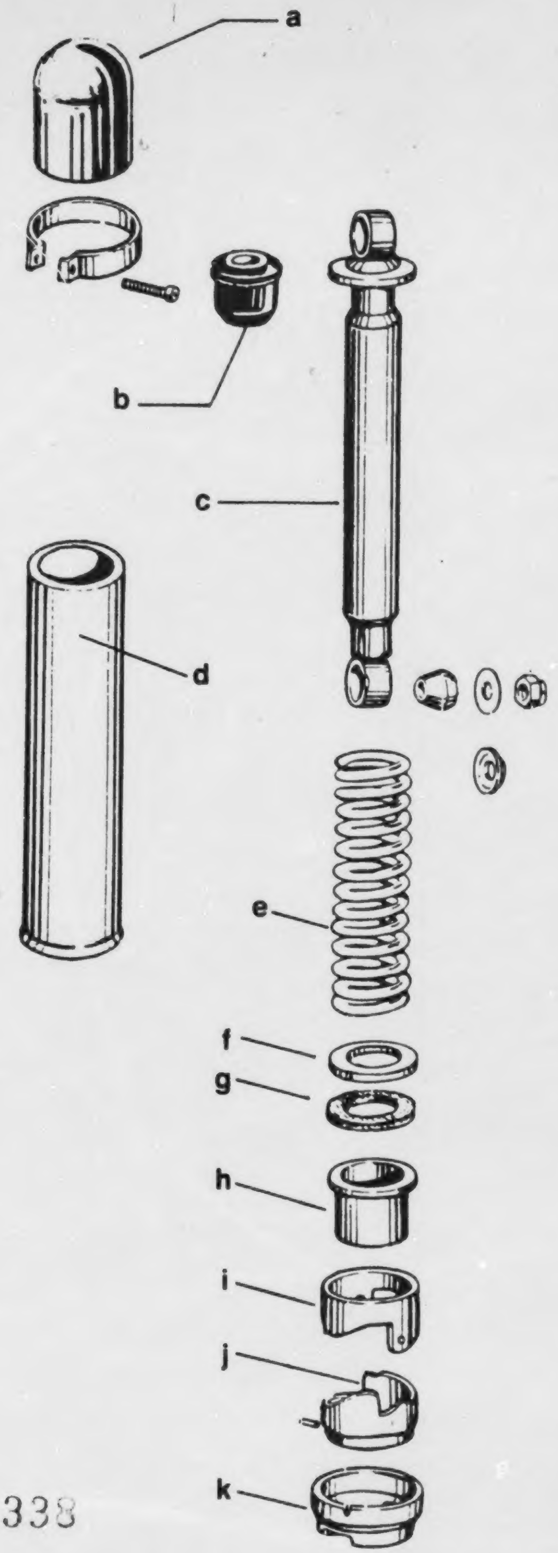
g. ______________________

h. ______________________

i. ______________________

j. ______________________

k. ______________________


a
b
c
d
e
f
g
h
i
j
k

4. Describe the operation of the rear swing arm suspension system on compression and rebound.

   a. Compression

   b. Rebound

5. Discuss rear shock absorber spring tension adjustment.

6. Demonstrate the ability to:

   a. Check and adjust rear shock absorbers.

   b. Remove, check, service, and install rear swing arm assembly.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

# REAR SWING ARM AND SHOCKS
# UNIT IV

## ANSWERS TO TEST

1. a. Swing arm
   b. Hydraulic shock absorber
   c. Spring
   d. Pivot bolt or shaft
2. a. Swing arm
   b. Bearing
   c. Short spacer
   d. Seals
   e. End cap
   f. Long spacer
   g. Pivot shaft
3. a. Top cover
   b. Rubber bumper
   c. Shock absorber
   d. Spring cover
   e. Spring
   f. Spacer washer
   g. Seal washer
   h. Cam sleeve
   i. Upper adjusting cam
   j. Lower adjusting cam
   k. Cam support

4. Description should include:
    a. Compression
        1) Over an irregularity in road surface, wheel moves upward causing rear swing arm to move upward
        2) Swing arm movement is restricted by
            a) Spring
            b) Oil within shock absorber
                (1) Oil forced from one part of shock to another
                (2) Oil flow controlled by restricting valves or ports
        3) Swing arm and shocks allow
            a) Rear wheel to move upward in reaction to road irregularity
            b) Frame and rider to receive only small portion of this movement
    b. Rebound
        1) Spring pushes shock and swing arm back down
        2) Swing arm carries wheel down to regain contact with road surface
        3) Swing arm movement again restricted by oil within shock absorber
            a) Oil is forced from one part of shock to another
            b) Oil flow controlled by restricting valves or ports
5. Discussion should include:
    a. Spring tension adjusted to compensate for load and road variations
    b. Spring tension adjusted by rotating cam device
        1) Low position for light loads
        2) Middle position for double riding
        3) High position for extra heavy loads
6. Performance skills evaluated to the satisfaction of the instructor

# KICKSTARTERS
## UNIT I

## UNIT OBJECTIVE

After completion of this unit, the student should be able to identify the parts and describe the operation of the different types of kickstarters. The student should also be able to service the pawl ratchet kickstarter. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define terms associated with kickstarters.
2. Select the common types of kickstarters.
3. Identify the parts of the pawl ratchet kickstarter.
4. Describe the operation of the pawl ratchet kickstarter.
5. Identify the parts of the full ratchet kickstarter.
6. Describe the operation of the full ratchet kickstarter.
7. Identify the parts of the lateral engagement kickstarter.
8. Describe the operation of the lateral engagement kickstarter.
9. Identify the parts of the quadrant gear kickstarter.
10. Describe the operation of the quadrant gear kickstarter.
11. Demonstrate the ability to remove, inspect, service, and replace a pawl ratchet kickstarter.

# KICKSTARTERS
## UNIT I

## SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss the procedure outlined in the job sheet.

  G. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Complete job sheet.

  D. Complete activities assigned by instructor.

  E. Take test.

## INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Common Types of Kickstarters

    2. TM 2--Pawl Ratchet Kickstarter Parts

    3. TM 3--Pawl Ratchet Kickstarter Operation

4. TM 4--Full Ratchet Kickstarter Parts
5. TM 5--Full Ratchet Kickstarter Operation
6. TM 6--Lateral Engagement Kickstarter Parts
7. TM 7--Lateral Engagement Kickstarter Operation
8. TM 8--Quadrant Gear Kickstarter Parts
9. TM 9--Quadrant Gear Kickstarter Operation

D. Job Sheet #1--Remove, Inspect, Service, and Replace a Pawl Ratchet Kickstarter

E. Test

F. Answers to test

II. References:

A. *Motorcycle Systems Training Manual-Motorcycle Power Train.* Kawasaki Motors Corp., 1973.

B. *Chilton's Repair and Tune-Up Guide for Harley-Davidson Singles.* Radnor, Pennsylvania: Chilton Book Co., 1973.

C. *Kawasaki 900 Service Manual.* Kawasaki Motors Corp.

D. *Chilton's Repair and Tune-Up Guide for Triumph Motorcycles.* Radnor, Pennsylvania: Chilton Book Co., 1973.

E. *Honda 450 Service Manual.* Honda Motor Co., Ltd., 1971.

F. *Suzuki 125 and T-125 Service Manual.* Suzuki Motor Co., Ltd., 1969.

# KICKSTARTERS
## UNIT I

## INFORMATION SHEET

I. Terms and definitions

   A. Pawl--Pivoted tongue that is adapted to fall into notches on another part to permit motion in only one direction

   B. Segment or quadrant gear--Half circular gear used on the kickstarters of many British motorcycles

   C. Ratchet--Mechanism having inclined teeth so that effective motion can be imparted to another mechanism in one direction only

II. Common types of kickstarters (Transparency 1)

   A. Pawl ratchet

   B. Full ratchet

   C. Lateral engagement

   D. Quadrant gear

III. Parts of pawl ratchet kickstarter (Transparency 2)

   A. Kickstarter lever assembly

   B. Kickstarter shaft oil seal

   C. Return spring guide

   D. Return spring

   E. Kickstarter stopper plate

   F. Snap ring

   G. Return spring holder

   H. Kickstarter shaft thrust washer

   I. Kickstarter shaft

   J. Thrust washer

   K. Kickstarter pinion gear

   (NOTE: This is called the drive gear by some manufacturers.)

## INFORMATION SHEET

   L. Kickstarter pawl

   M. Pawl pin

   N. Pawl spring

IV. Operation of pawl ratchet kickstarter (Transparency 3)

   A. Pawl is pushed up by the pawl spring to engage the teeth on the inside of kickstarter pinion gear when lever is depressed

   B. Kickstarter pinion gear turns crankshaft to start engine

   C. Ratchet mechanism provides for engagement of kickstarter lever to engine crankshaft when starting and disengagement of lever and crankshaft when engine is running

   D. Pawl is moved against the kickstarter stopper plate and held out of engagement to allow the kickstarter pinion gear to rotate freely when the kickstarter lever is returned by the return spring

V. Parts of full ratchet kickstarter (Transparency 4)

   A. Kickpedal

   B. Spring guide

   C. Return spring

   D. Kickstarter shaft

   E. Kickstarter pinion gear

   F. Ratchet

   G. Ratchet tab

   H. Ratchet spring

   I. Spring cap

VI. Operation of full ratchet kickstarter (Transparency 5)

   A. Spring pushes ratchet into engagement with teeth on kickstarter pinion gear when kickstarter shaft is turned by downward motion of kickpedal

   B. Kickstarter pinion gear turns crankshaft to start engine

## INFORMATION SHEET

C. Ratchet tab is caught by the curved ratchet guide and separates kickpedal and kickstarter pinion gear when spring returns kickpedal

(NOTE: The operation of the full ratchet kickstarter is very similar to the operation of the pawl ratchet kickstarter.)

VII. Parts of lateral engagement kickstarter (Transparency 6)

A. Kickpedal

B. Washer

C. Snap ring

D. Kickstarter spring

E. Kickstarter shaft

F. Kickstarter pinion gear

G. Friction spring

VIII. Operation of lateral engagement kickstarter (Transparency 7)

A. Kickstarter shaft rotation causes kickstarter pinion gear to move sideways along spiral splines and engages the idler due to resistance to rotation caused by the friction spring

B. Idler gear turns crankshaft to start engine

C. Kickstarter pinion gear is driven back along splines to the disengaged position as engine speed becomes greater than kickstarter shaft speed

D. Kickstarter pinion gear is held in the "at rest" position by the resistance of the friction spring

IX. Parts of quadrant gear kickstarter (Transparency 8)

A. Kickpedal

B. Return spring

C. Quadrant gear and shaft

D. Ratchet

E. Kickstarter pinion gear

## INFORMATION SHEET

X. Operation of quadrant gear kickstarter (Transparency 9)

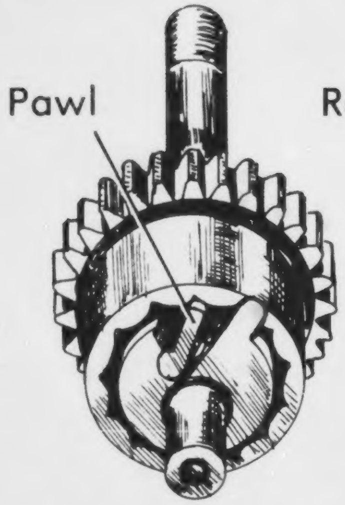
   A. Quadrant gear rotates and engages kickstarter pinion gear when kickpedal is depressed

   B. Kickstarter pinion gear is connected to engine through spring loaded ratchet clutch on transmission shaft

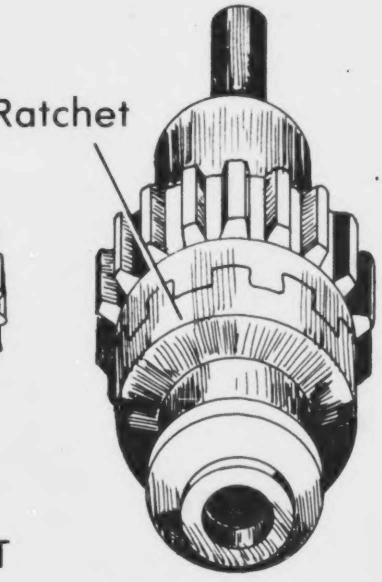
   C. Quadrant gear is rotated out of engagement when kickpedal is released

   D. Ratchet clutch and kickstarter pinion gear rotate freely on transmission mainshaft when quadrant gear is out of mesh

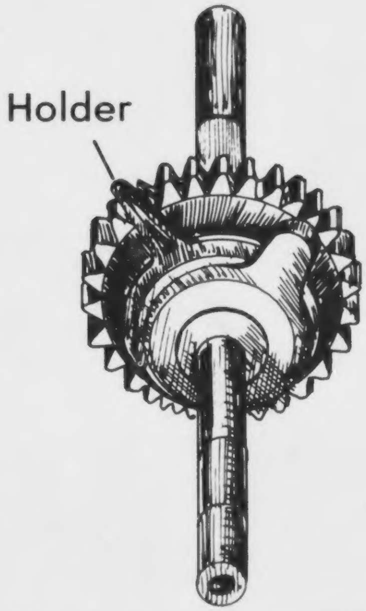
# COMMON TYPES OF KICKSTARTERS



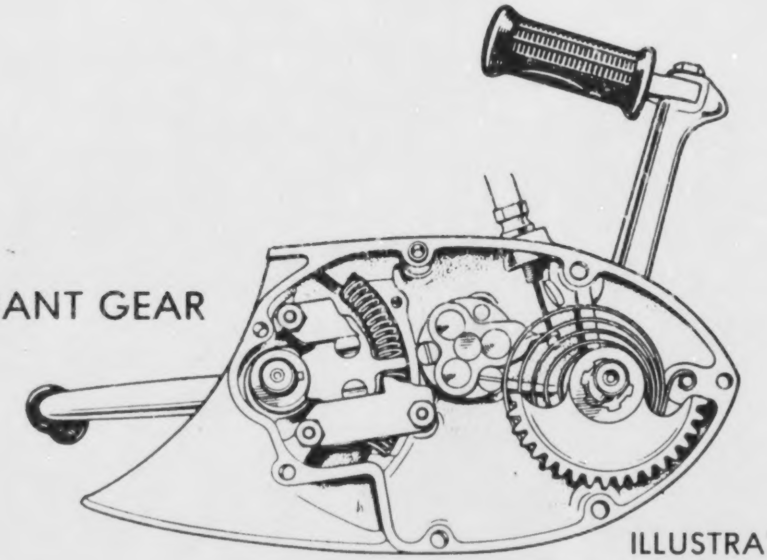
PAWL RATCHET



FULL RATCHET



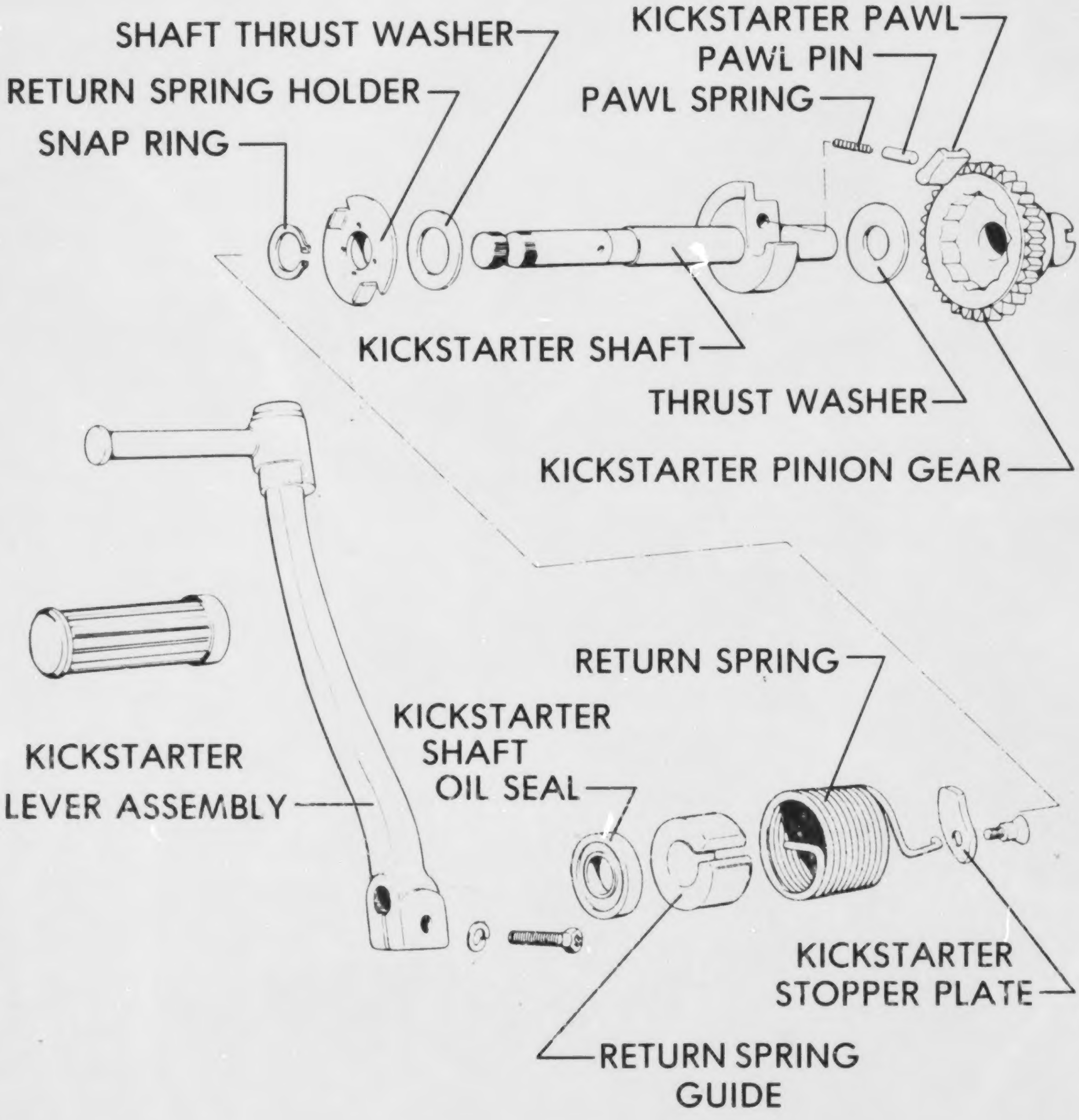
LATERAL ENGAGEMENT



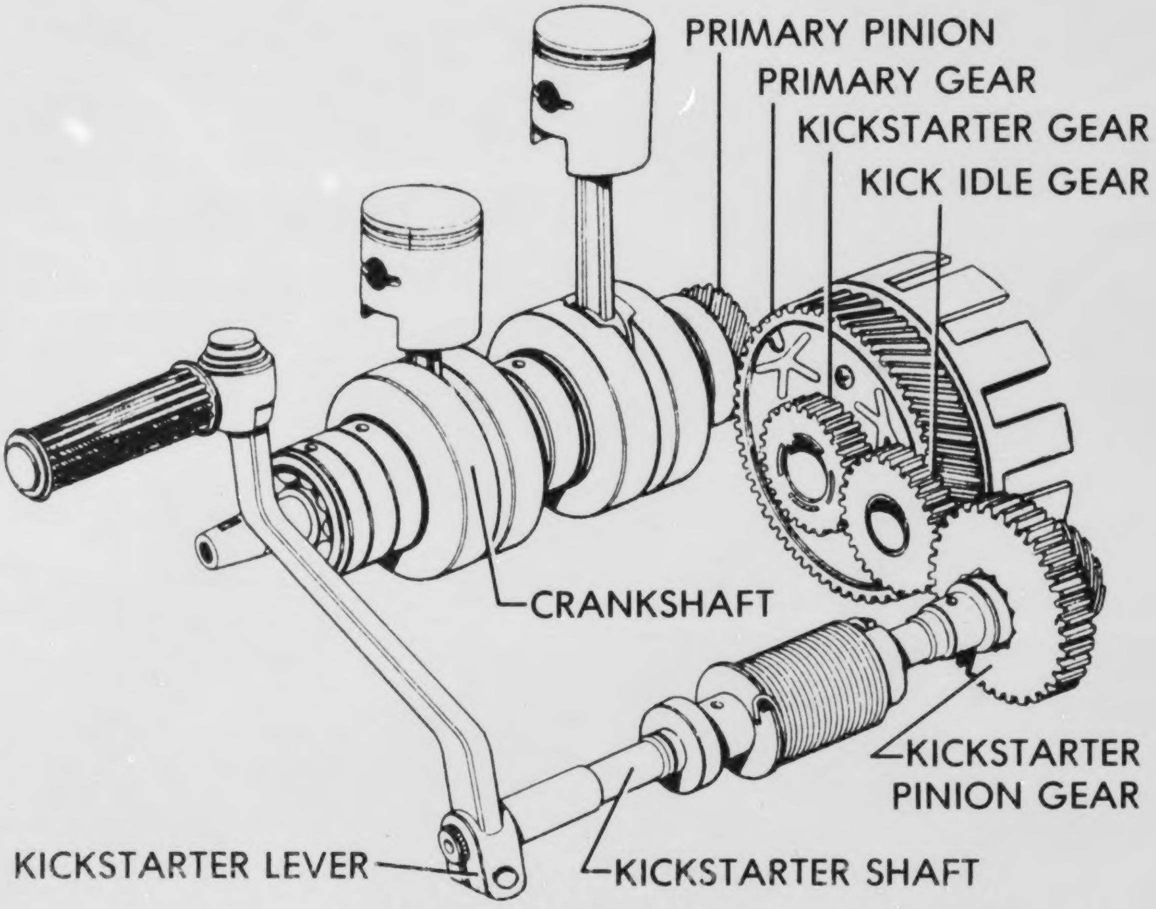
QUADRANT GEAR

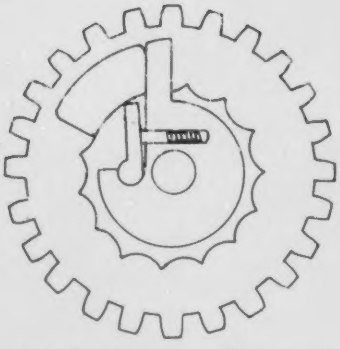
ILLUSTRATION BY
NORTON-TRIUMPH CORPORATION

# PAWL RATCHET KICKSTARTER PARTS

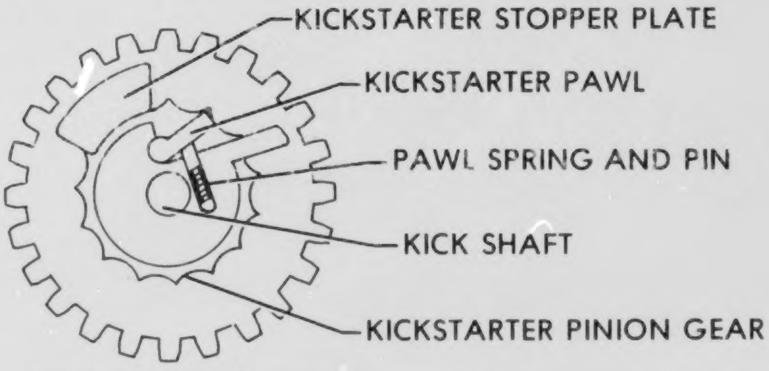

SHAFT THRUST WASHER
RETURN SPRING HOLDER
SNAP RING
KICKSTARTER PAWL
PAWL PIN
PAWL SPRING
KICKSTARTER SHAFT
THRUST WASHER
KICKSTARTER PINION GEAR
RETURN SPRING
KICKSTARTER SHAFT OIL SEAL
KICKSTARTER LEVER ASSEMBLY
KICKSTARTER STOPPER PLATE
RETURN SPRING GUIDE

# PAWL RATCHET KICKSTARTER OPERATION


PRIMARY PINION
PRIMARY GEAR
KICKSTARTER GEAR
KICK IDLE GEAR
CRANKSHAFT
KICKSTARTER PINION GEAR
KICKSTARTER LEVER
KICKSTARTER SHAFT

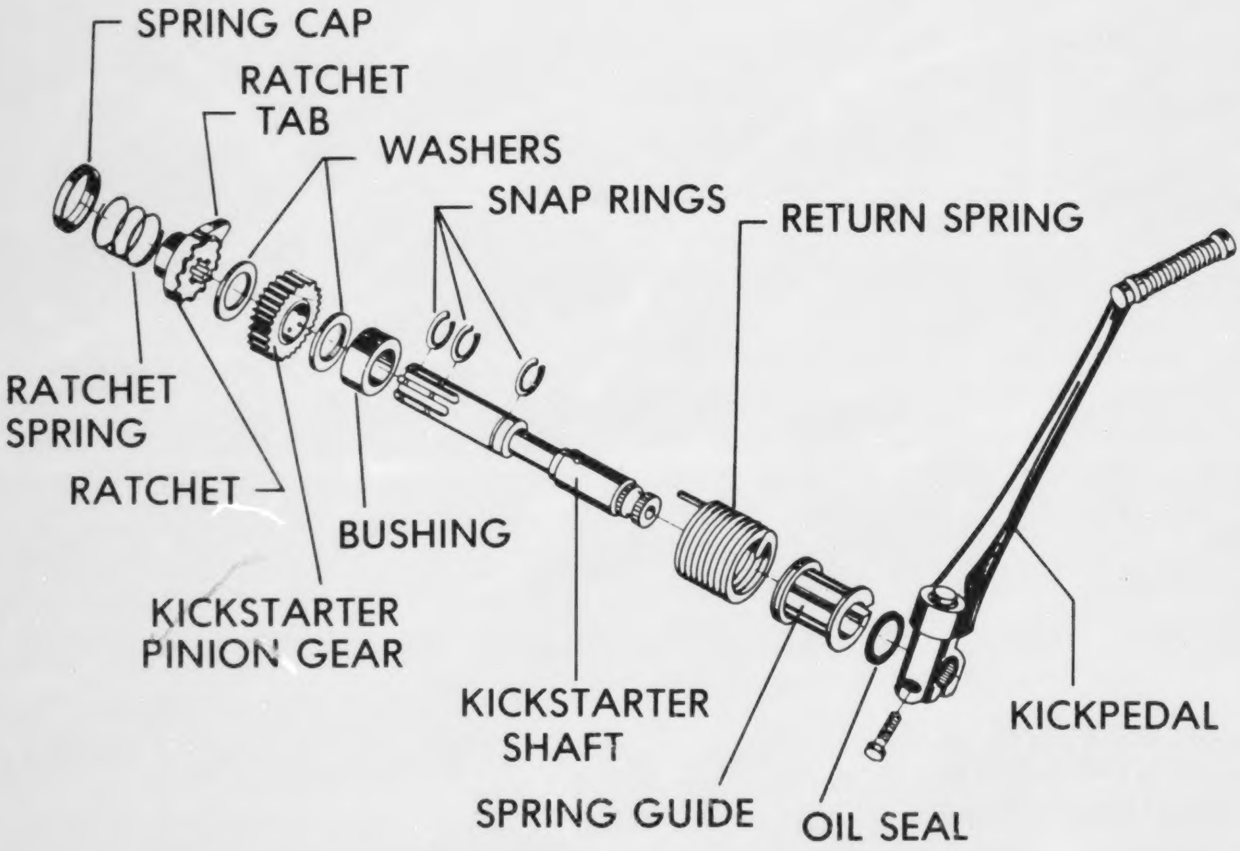


Kickstarter lever released

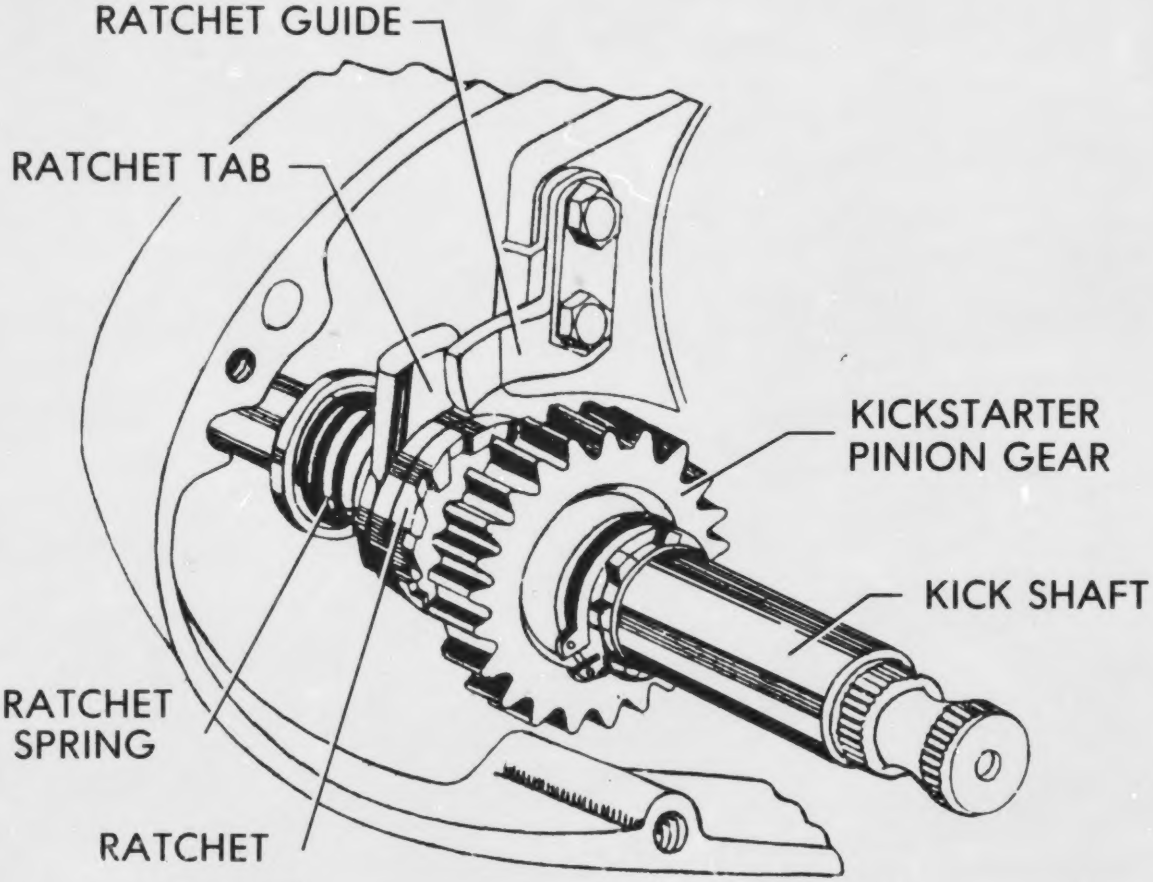

KICKSTARTER STOPPER PLATE
KICKSTARTER PAWL
PAWL SPRING AND PIN
KICK SHAFT
KICKSTARTER PINION GEAR

Kickstarter lever depressed

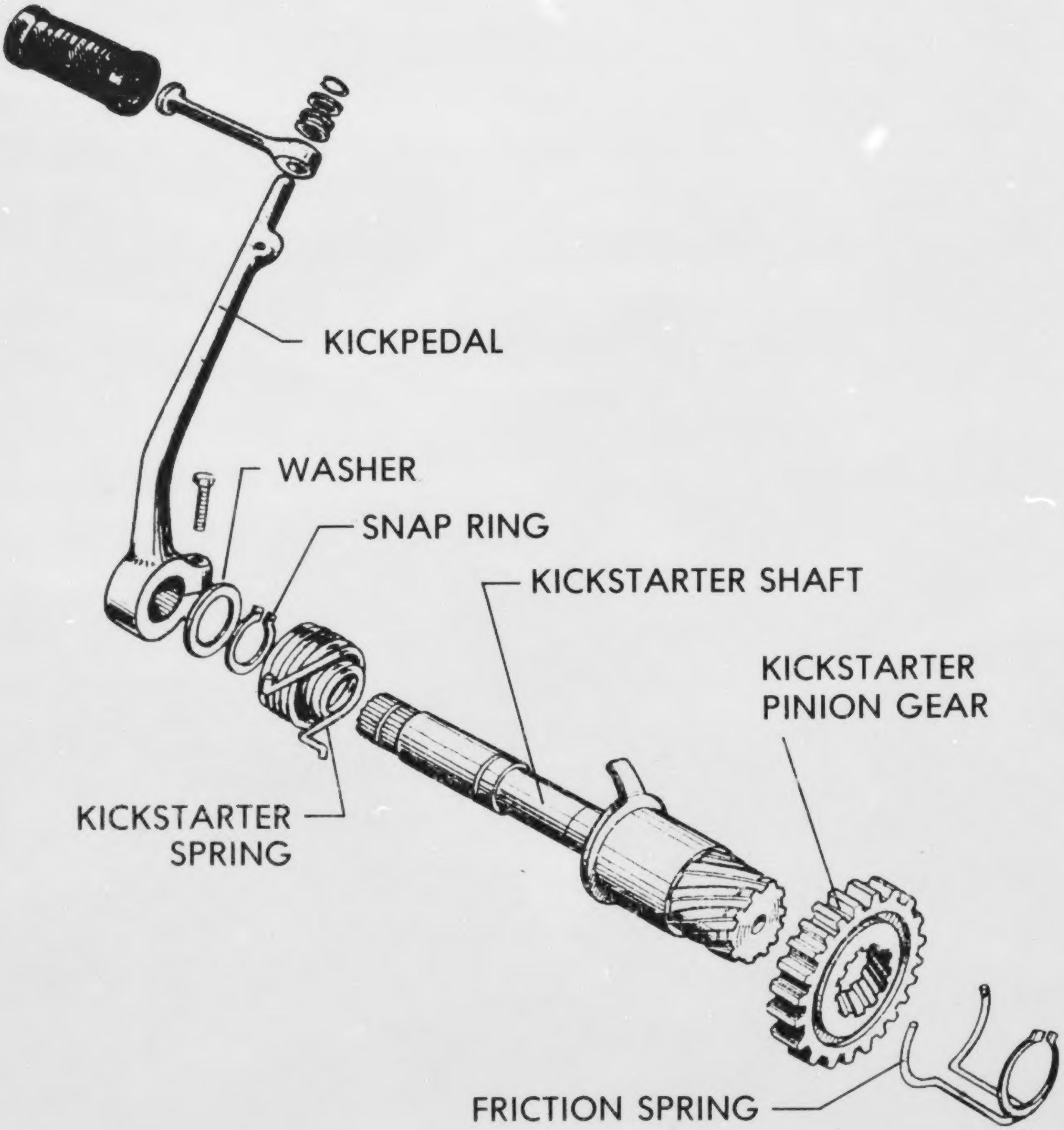
# FULL RATCHET KICKSTARTER PARTS


SPRING CAP
RATCHET TAB
WASHERS
SNAP RINGS
RETURN SPRING
RATCHET SPRING
RATCHET
BUSHING
KICKSTARTER PINION GEAR
KICKSTARTER SHAFT
SPRING GUIDE
OIL SEAL
KICKPEDAL

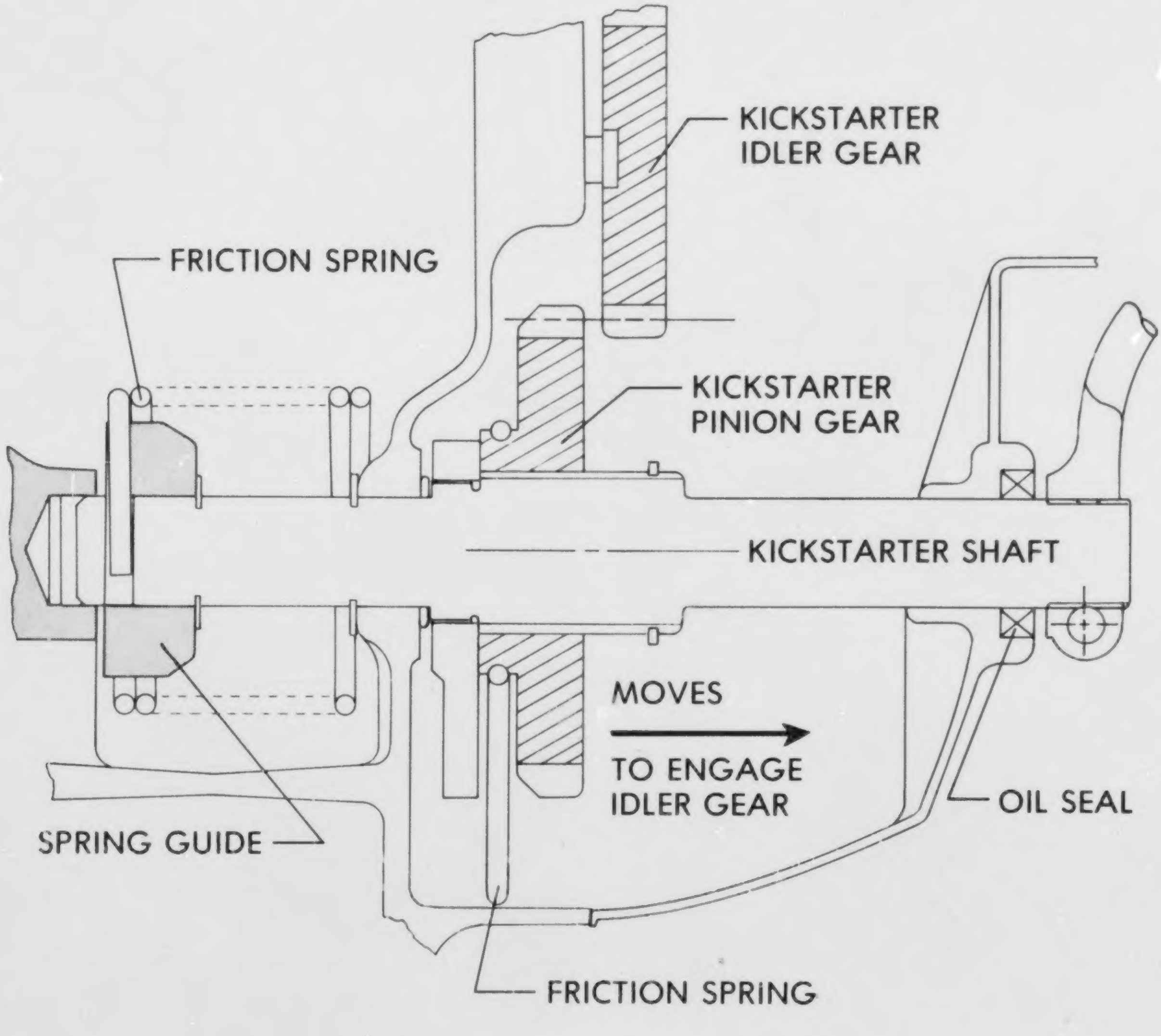
# FULL RATCHET KICKSTARTER OPERATION


RATCHET GUIDE
RATCHET TAB
KICKSTARTER PINION GEAR
KICK SHAFT
RATCHET SPRING
RATCHET

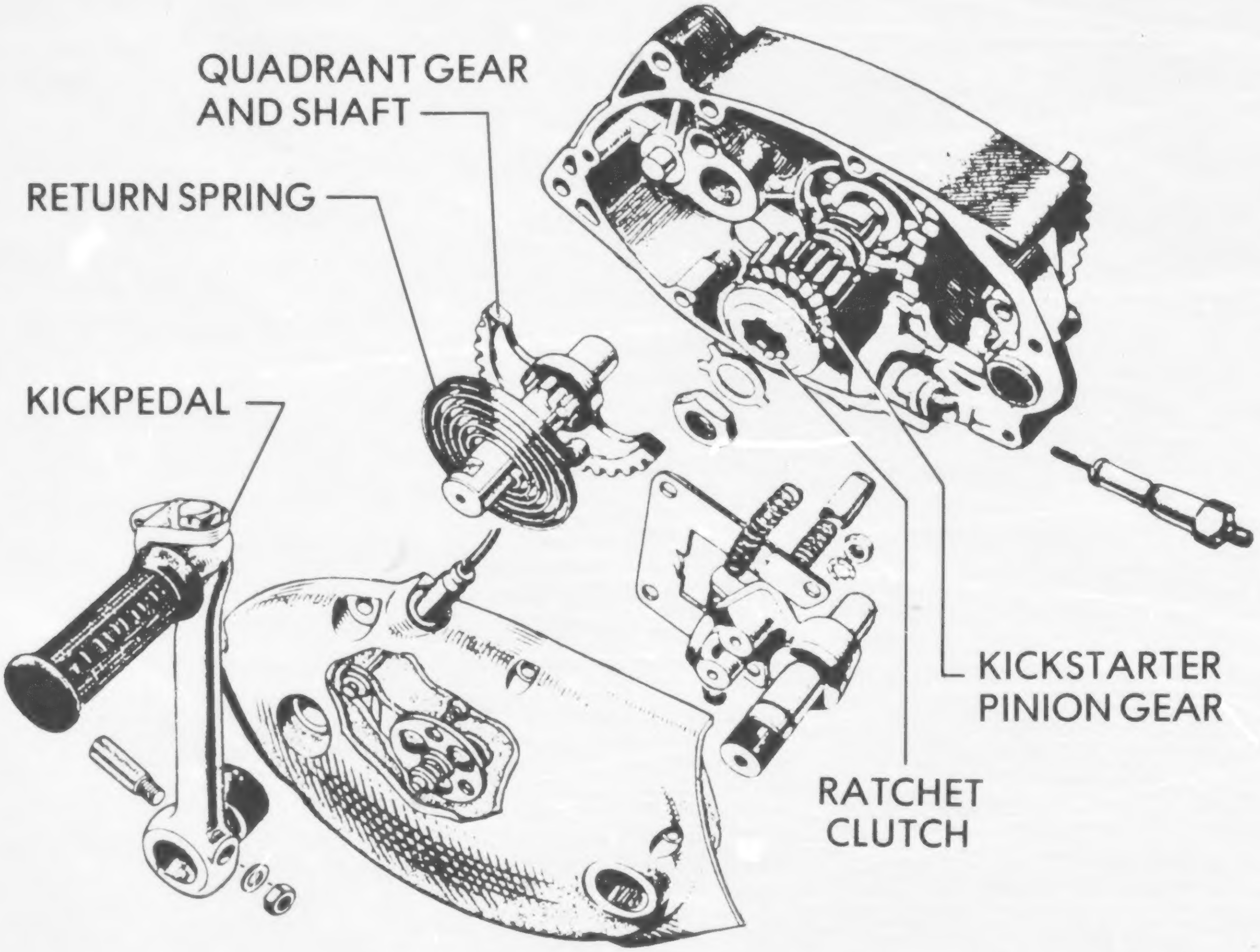
# LATERAL ENGAGEMENT KICKSTARTER PARTS


KICKPEDAL
WASHER
SNAP RING
KICKSTARTER SHAFT
KICKSTARTER PINION GEAR
KICKSTARTER SPRING
FRICTION SPRING

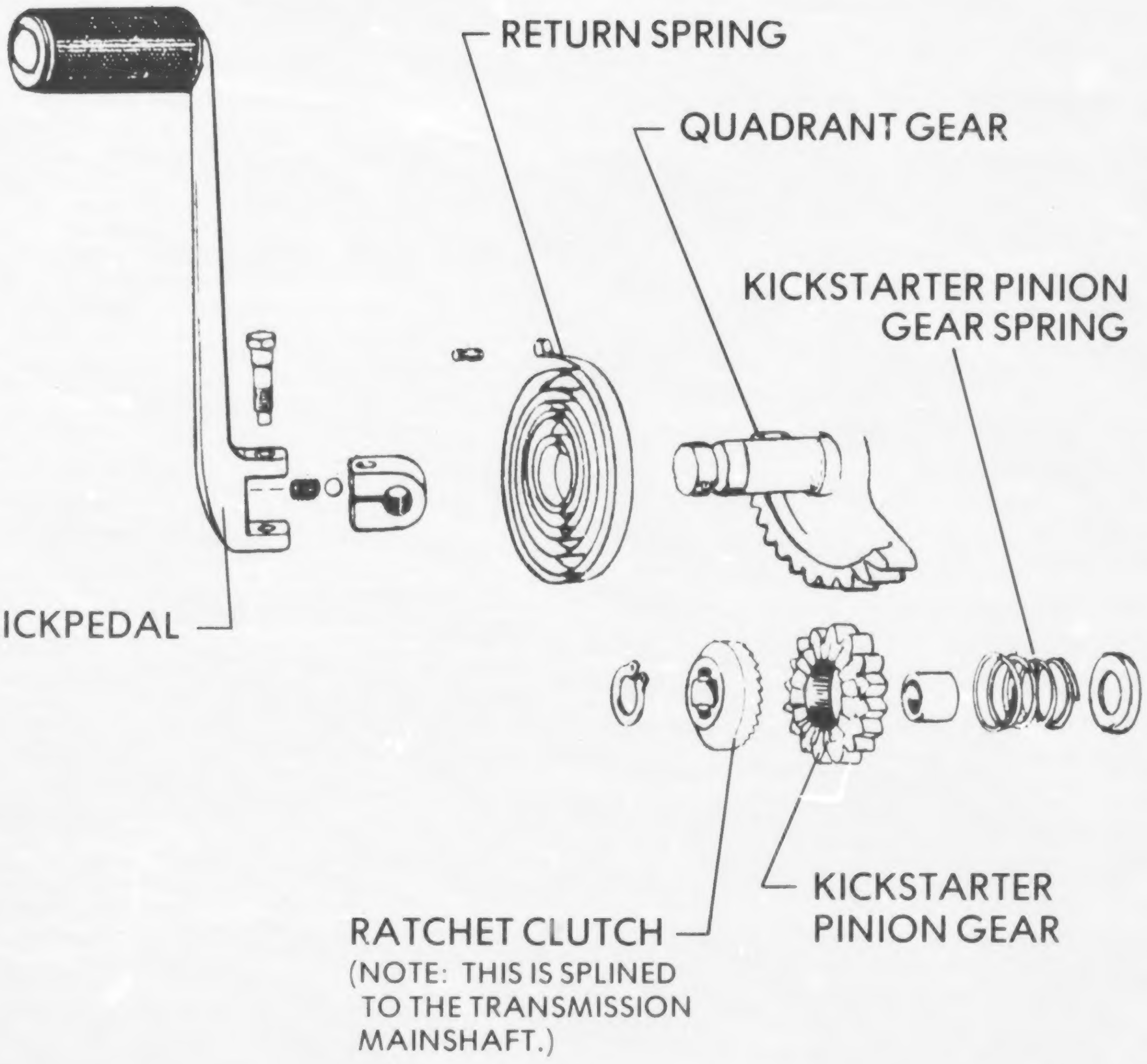
# LATERAL ENGAGEMENT KICKSTARTER OPERATION


KICKSTARTER IDLER GEAR
FRICTION SPRING
KICKSTARTER PINION GEAR
KICKSTARTER SHAFT
MOVES
TO ENGAGE IDLER GEAR
OIL SEAL
SPRING GUIDE
FRICTION SPRING

# QUADRANT GEAR KICKSTARTER PARTS


QUADRANT GEAR AND SHAFT
RETURN SPRING
KICKPEDAL
KICKSTARTER PINION GEAR
RATCHET CLUTCH

# QUADRANT GEAR KICKSTARTER OPERATION


RETURN SPRING
QUADRANT GEAR
KICKSTARTER PINION GEAR SPRING
KICKPEDAL
KICKSTARTER PINION GEAR
RATCHET CLUTCH
(NOTE: THIS IS SPLINED TO THE TRANSMISSION MAINSHAFT.)

# KICKSTARTERS
## UNIT I

## JOB SHEET #1--REMOVE, INSPECT, SERVICE, AND REPLACE A PAWL RATCHET KICKSTARTER

I. Tools and materials

A. Motorcycle engine equipped with a pawl ratchet kickstarter

B. Hand tool assortment

C. Metric wrenches

D. Washpan and cleaning solvent

E. Appropriate service manual

F. Safety glasses

II. Procedure

A. Separate the transmission and crankcase halves

(NOTE: The service manual should be consulted for the information required to separate the halves.)

B. Remove the kickstarter

C. Remove snap rings and disassemble kickstarter assembly, keeping all component parts in order

D. Inspect the internal teeth of the kickstarter pinion gear for wear (Figure 1)

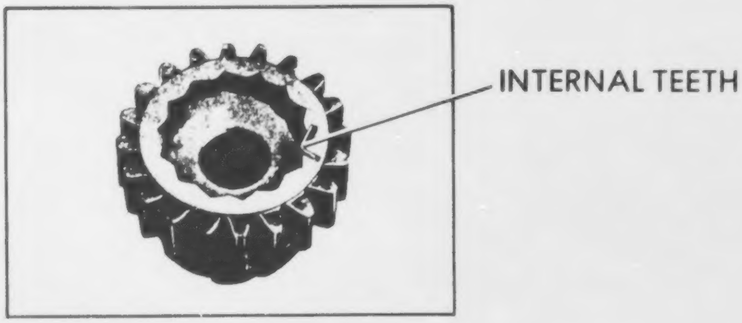


FIGURE 1

## JOB SHEET #1

E. Inspect the kickstarter pawl for wear, especially at the tip that engages the kickstarter pinion gear teeth (Figure 2)

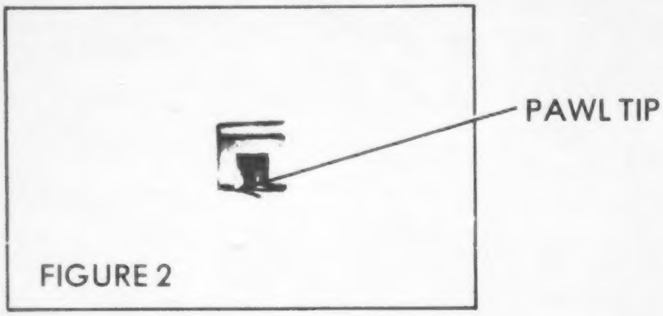


FIGURE 2

F. Check the pawl spring and pin by pushing it in to see if it operates properly (Figure 3)

(NOTE: It should work smoothly and have adequate spring tension.)

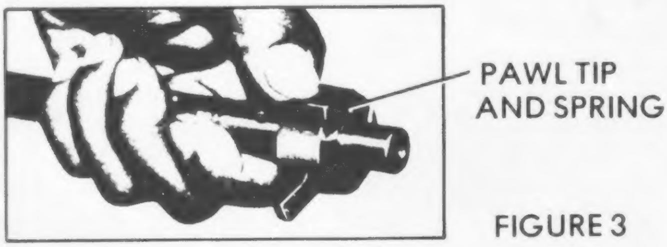


FIGURE 3

G. Wash all parts and reassemble the kickstarter assembly

H. Replace the kickstarter assembly and reassemble the case halves of the engine

# KICKSTARTERS
# UNIT I

## TEST

1. Define the terms associated with kickstarters.

   a. Pawl--

   b. Segment or quadrant gear--

   c. Ratchet--

2. Select the common types of kickstarters by placing an "X" in the appropriate blank.

   ______a. Lateral engagement

   ______b. Constant mesh

   ______c. Half ratchet

   ______d. Pawl ratchet

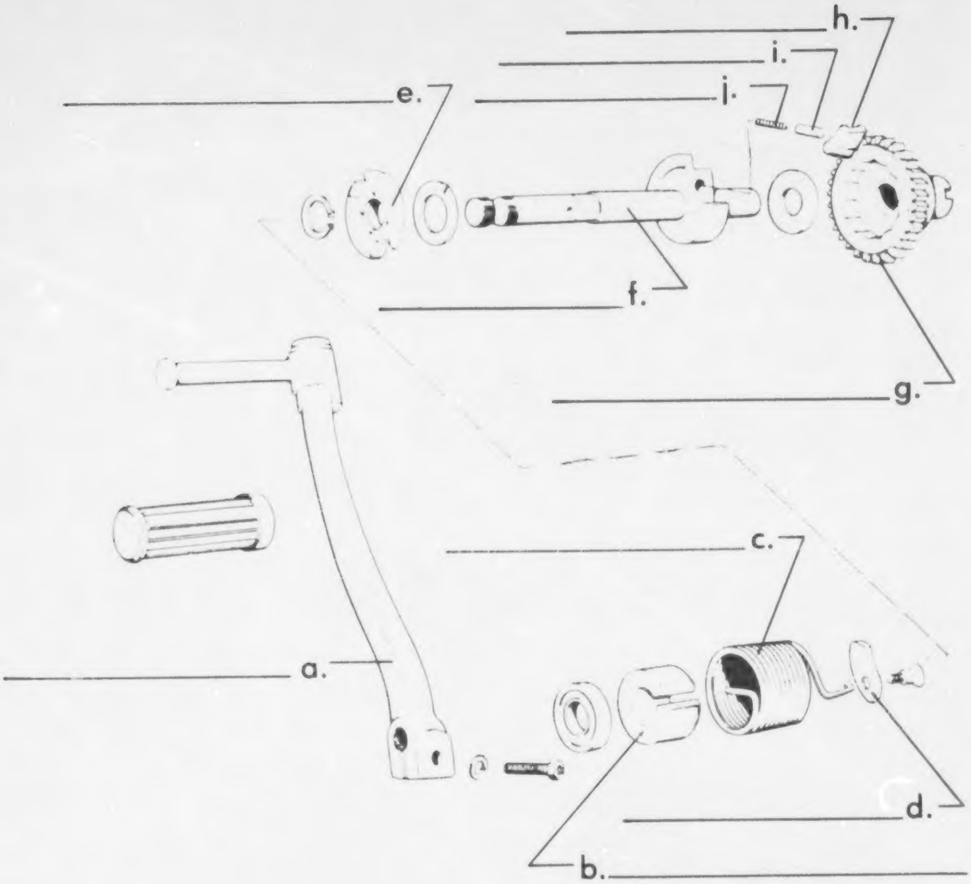
   ______e. Radial engagement

   ______f. Quadrant gear

   ______g. Spring release

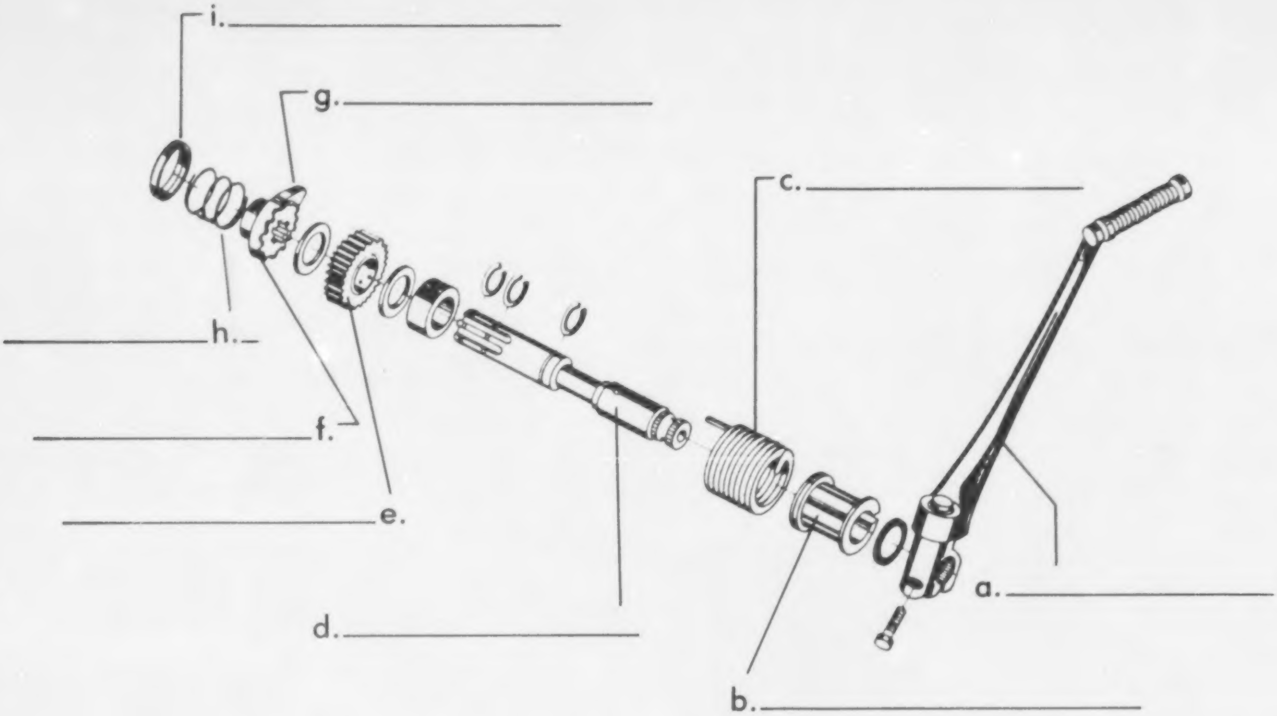
   ______h. Full ratchet

3. Identify the parts of the pawl ratchet kickstarter.



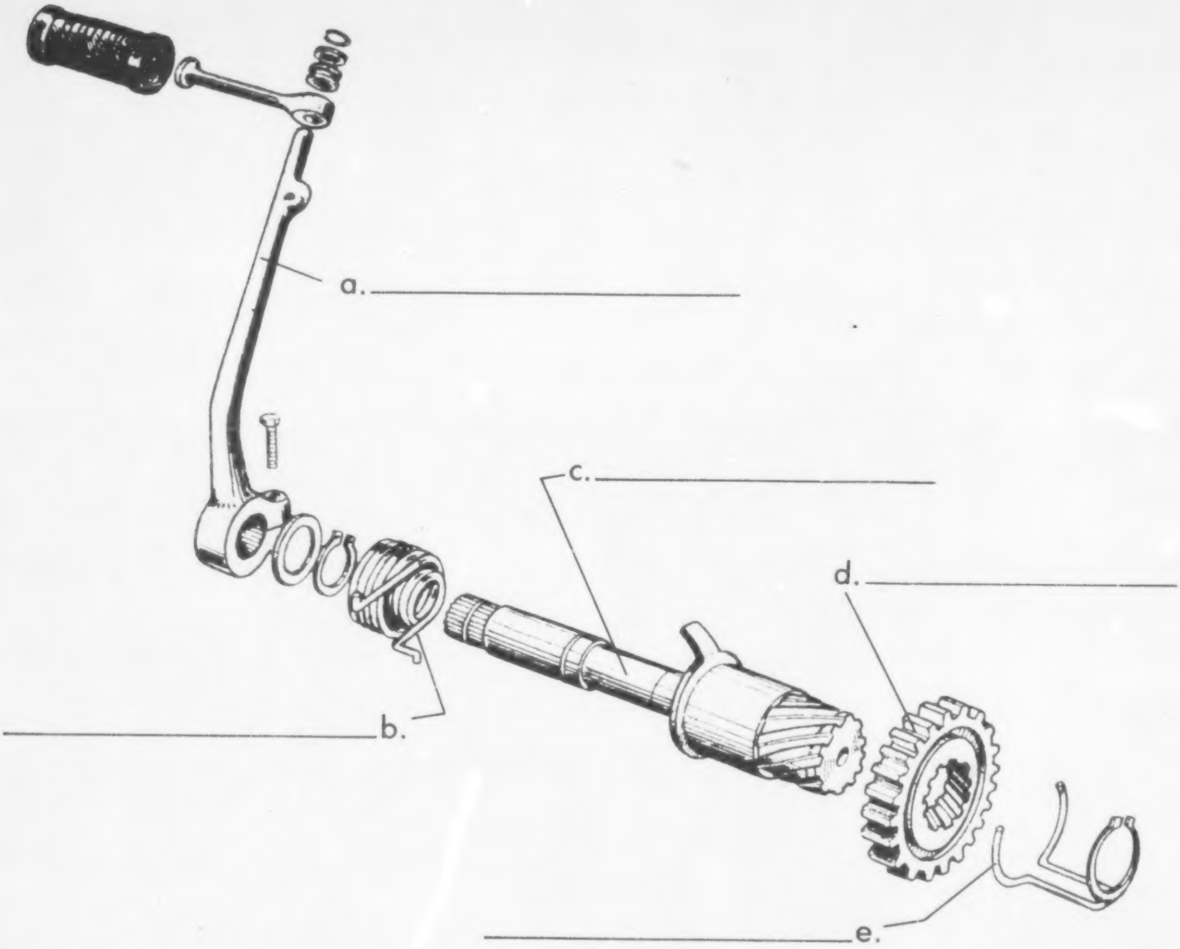
4. Describe the operation of the pawl ratchet kickstarter.

5. Identify the parts of the full ratchet kickstarter.



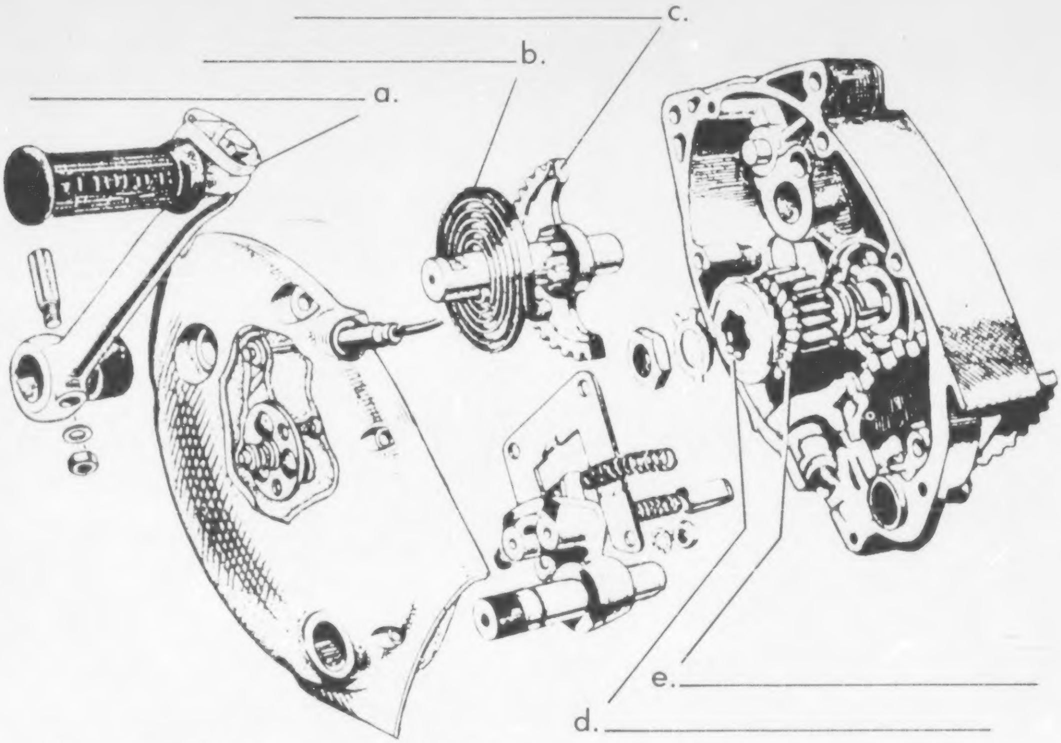
6. Describe the operation of the full ratchet kickstarter.

7. Identify the parts of the lateral engagement kickstarter.



8. Describe the operation of the lateral engagement kickstarter.

9. Identify the parts of the quadrant gear kickstarter.



10. Describe the operation of the quadrant gear kickstarter.

11. Demonstrate the ability to remove, inspect, service, and replace a pawl ratchet kickstarter.

(NOTE: If this activity has not been accomplished prior to the test, ask your instructor when it should be completed.)

# KICKSTARTERS
## UNIT I

## ANSWERS TO TEST

1. a. Pawl--Pivoted tongue that is adapted to fall into notches on another part to permit motion in only one direction

   b. Segment or quadrant gear--Half circular gear used on the kickstarters of many British motorcycles

   c. Ratchet--Mechanism having inclined teeth so that effective motion can be imparted to another mechanism in one direction only

2. a, d, f, h

3. a. Kickstarter lever assembly

   b. Return spring guide

   c. Return spring

   d. Kickstarter stopper plate

   e. Return spring holder

   f. Kickstarter shaft

   g. Kickstarter pinion gear

   h. Kickstarter pawl

   i. Pawl pin

   j. Pawl spring

4. Description should include:

   a. Pawl is pushed up by the pawl spring to engage the teeth on the inside of the kickstarter pinion gear when lever is depressed

   b. Kickstarter pinion gear turns crankshaft to start engine

   c. Ratchet mechanism provides for engagement of kickstarter lever to engine crankshaft when starting and disengagement of lever and crankshaft when engine is running

   d. Pawl is moved against the kickstarter stopper plate and held out of engagement to allow the kickstarter pinion gear to rotate freely when the kickstarter lever is returned by the return spring

5. a. Kickpedal
   b. Spring guide
   c. Return spring
   d. Kickstarter shaft
   e. Kickstarter pinion gear
   f. Ratchet
   g. Ratchet tab
   h. Ratchet spring
   i. Spring cap

6. Description should include:
   a. Spring pushes ratchet into engagement with teeth on kickstarter pinion gear when kickstarter shaft is turned by downward motion of kickpedal
   b. Kickstarter pinion gear turns crankshaft to start engine
   c. Ratchet tab is caught by the curved ratchet guide and separates kickpedal and kickstarter pinion gear when spring returns kickpedal

7. a. Kickpedal
   b. Kickstarter spring
   c. Kickstarter shaft
   d. Kickstarter pinion gear
   e. Friction spring

8. Description should include:
   a. Kickstarter shaft rotation causes kickstarter pinion gear to move sideways along spiral splines and engages the idler due to resistance to rotation caused by the friction spring
   b. Idler gear turns crankshaft to start engine
   c. Kickstarter pinion gear is driven back along splines to the disengaged position as engine speed becomes greater than kickstarter shaft speed
   d. Kickstarter pinion gear is held in the "at rest" position by the resistance of the friction spring

9.
   a. Kickpedal
   b. Return spring
   c. Quadrant gear and shaft
   d. Ratchet
   e. Kickstarter pinion gear

10. Description should include:
   a. Quadrant gear rotates and engages kickstarter pinion gear when kickpedal is depressed
   b. Kickstarter pinion gear is connected to engine through spring loaded ratchet clutch on transmission shaft
   c. Quadrant gear is rotated out of engagement when kickpedal is released
   d. Ratchet clutch and kickstarter pinion gear rotate freely on transmission mainshaft when quadrant gear is out of mesh

11. Performance skill evaluated to the satisfaction of the instructor

# AC PERMANENT MAGNET SINGLE PHASE CHARGING SYSTEM
## UNIT I

## UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms and definitions associated with the AC permanent magnet single phase charging system and select the components of this system. The student should also be able to distinguish between the two types of charging systems and describe the operations of each type. The student should also demonstrate the ability to perform tests and service on various systems using the proper equipment and wiring diagrams. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with AC permanent magnet charging systems to the correct definitions.
2. Select the components of the AC permanent magnet single phase charging system.
3. Identify the types of single phase coil connections.
4. Distinguish between the two types of charging systems.
5. Describe the operation of the half-wave charging system.
6. Describe the operation of the full-wave charging system.
7. Demonstrate the ability to:
    a. Test DC charging rate.
    b. Test alternator charging and lighting coils output.
    c. Test stator assembly, rectifiers, and regulators.

## AC PERMANENT MAGNET SINGLE PHASE CHARGING SYST
## UNIT I

### SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss the procedures outlined in the job sheets.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheets.

   D. Complete activities assigned by instructor.

   E. Take test.

### INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Components of Charging System

      2. TM 2--Single Phase Coil Connections

      3. TM 3--Operation of Half-Wave Charging System

    4. TM 4--Half-Wave Rectification
    5. TM 5--Single Coil System
    6. TM 6--Multiple Coil System
    7. TM 7--Full-Wave Operation - Bridge Type Rectifier and SCR
    8. TM 8--Voltage Regulating Devices

D. Job sheets

    1. Job Sheet #1--Test DC Charging Rate
    2. Job Sheet #2--Test Alternator Charging and Lighting Coils Output
    3. Job Sheet #3--Test Stator Assembly, Rectifiers, and Regulators

E. Test

F. Answers to test

II. References:

A. *Suzuki Constructions and Works of Electrical Equipments*. Suzuki Motor Co., Ltd.

B. *Motorcycle Systems Training Manual - Motorcycle Electrical Circuits*. P/N 99995-447. Kawasaki Motors Corp., 1973.

C. *Suzuki Electrical Systems and Accessories Training Handouts*. U.S. Suzuki Technical Training Center. Suzuki Motor Co., Ltd.

D. *Motorcycle Electrical Equipment Service Manual*. Publication No. 3621. Joseph Lucas Ltd.

E. *Honda Motorcycle and Power Products Training Manual*. Gardena, California: American Honda Motor Co., Inc.

F. *Honda CB450-CL450 Service Manual*. Honda Motor Co., Ltd., 1971.

G. *Honda CB200-CL200 Service Manual*. Honda Motor Co., Ltd., 1974.

# AC PERMANENT MAGNET SINGLE PHASE CHARGING SYSTEM
## UNIT I

## INFORMATION SHEET

I. Terms and definitions

A. Alternator--Generator that uses a revolving magnet and stationary stator windings to produce alternating current

B. Diode--Device that allows a current to pass through in only one direction

C. Rectifier--Device in the charging system that changes alternating current (AC) to direct current (DC)

D. Regulator--Device to limit the output of the alternator and prevent overcharging of the battery

E. Silicon--Semiconducting material used in the construction of diodes

F. Selenium--Semiconducting material used as a rectifier on older motorcycles

G. Stator--Stationary coils of an alternator

H. Zener diode--Diode that will flow current in a reverse direction when a reverse directional voltage of a predetermined value is applied

I. Magnetic induction--Current produced in a conductor when moved through a magnetic field

J. Magneto--Alternator with permanent magnets used to generate current for an internal combustion engine

(NOTE: To avoid confusion the term "magneto" will not be used to mean alternator in this unit since "magneto" is often used to identify a type of ignition system.)

K. Rotor--Rotating part of an alternator which contains permanent magnets

L. Silicon controlled rectifier (SCR)--Electronically controlled switch that acts as a voltage regulator in the charging system

M. Lighting coil--Stator coil (or coils) used to produce current to operate the lights

N. Heat sink--Device for the absorption of unwanted heat

## INFORMATION SHEET

II. Components of a typical charging system (Transparency 1)

- A. Rotor (or flywheel)
- B. Stator assembly (charging and lighting coils)
- C. Rectifier
- D. Regulator
- E. Battery
- F. Connecting wires

III. Types of single phase coil connections (Transparency 2)

- A. Single coil
- B. Multiple coil
  - 1. Parallel connected
  - 2. Series connected
  - 3. Series-parallel connected

IV. Types of charging systems

- A. Half-wave system--Allows only one-half of the generated current, only positive waves, to pass to the battery
- B. Full-wave system--Allows all of the generated current, both positive and negative waves, to pass to the battery

V. Operation of half-wave charging system

- A. Current produced is alternating current
  - 1. Suitable for lighting
  - 2. Not suitable for charging DC battery
- B. Rotor with cast-in magnets rotates past stator and lighting coils (Transparency 3)
  - 1. Rotor moves 180°
    - a. Magnetic field of north pole moves across coil
    - b. Current is induced in coil

## INFORMATION SHEET

    c. Current flows in one direction represented by sine wave rising above neutral or horizontal line
    d. Positive voltage
  2. Rotor moves another 180°
    a. Magnetic field of south pole moves across coil
    b. Current is induced in coil
    c. Current flows in opposite direction represented by sine wave dropping below neutral or horizontal line
    d. Negative voltage

C. Diode used to rectify current (Transparency 4)
  1. Allows positive wave (current) to pass
  2. Does not allow negative wave (current) to pass
  3. Only 1/2 of total waves (currents) pass to battery
  4. Current moves in the same direction thus becoming DC

D. Electrical needs vary (Transparencies 5 and 6)
  1. Day--Charge battery only
    a. 1/2 of the coils of a multiple coil system
    b. 1/2 of the coils of a single coil system
  2. Night--Charge battery and operate lights
    a. All coils of a multiple coil system
      1) 1/2 of the coils to charge battery
      2) 1/2 of the coils to power lights
    b. Both halves of a single coil system
      1) 1/2 of the coil to charge battery
      2) 1/2 of the coil to power lights

## INFORMATION SHEET

VI. Operation of full-wave charging system

- A. System uses both positive and negative waves to charge the battery
- B. Two types of full-wave systems
    - 1. Connect or disconnect additional stator coils for day or night use
        - a. Similar to half-wave system
        - b. Voltage regulator may or may not be used
    - 2. All coils permanently connected into circuit
        - a. Engine speed determines alternator output
        - b. Requires voltage regulating devices
            - 1) Silicon controlled rectifier
            - 2) Zener diode
- C. Bridge type rectifier used to change AC to DC (Transparency 7)
    - 1. Magnets pass north to south past the coils causing positive current to flow
        - a. From coils to terminal 1 of rectifier
        - b. Through diode B to terminal 2

          (NOTE: Diode A blocks the current from passing from terminal 1 to terminal 4.)
        - c. From terminal 2 through battery back to terminal 4 or grounded side of rectifier
        - d. Through diode D to terminal 3 and back to coils to complete circuit
    - 2. Magnets pass south to north past the coils causing negative current to flow
        - a. From coils to terminal 3 of rectifier
        - b. Through diode 3 to terminal 2

          (NOTE: Diode D blocks current from passing from terminal 3 to terminal 4.)

## INFORMATION SHEET

        c. From terminal 2 through battery back to terminal 4 or grounded side of rectifier

        d. Through diode A to terminal 1 and back to coils to complete circuit

    3. Both the positive and the negative waves of current pass through the battery in the same direction

D. Voltage regulation (Transparency 8)

    1. Silicon controlled rectifier (SCR)

        a. Electronic switch activated when voltage across the battery terminals is high enough to cause damage to battery and other electrical units

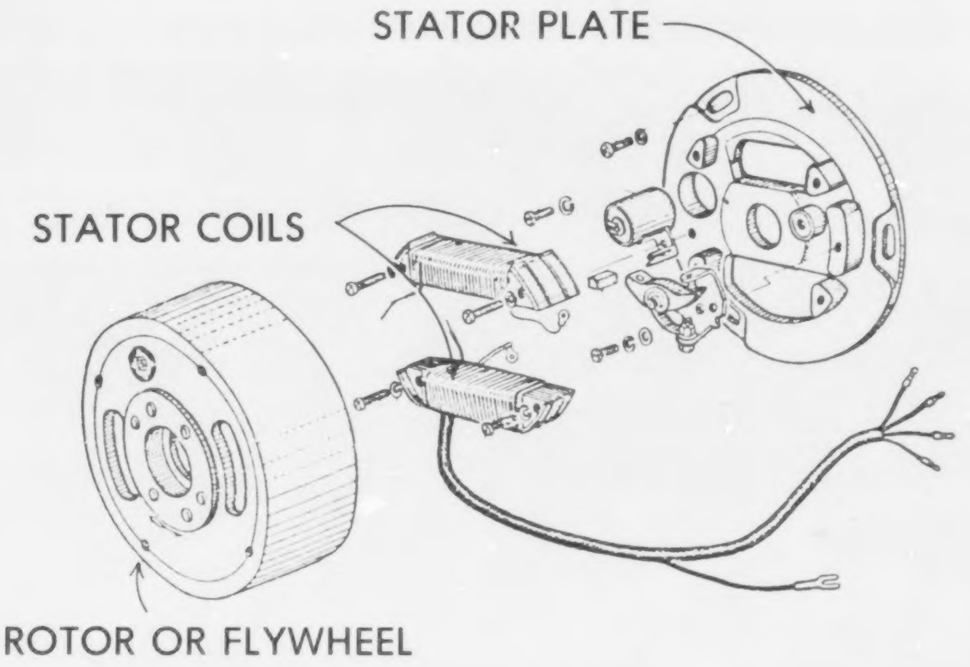
        b. Allows charging current to by-pass battery and return to alternator

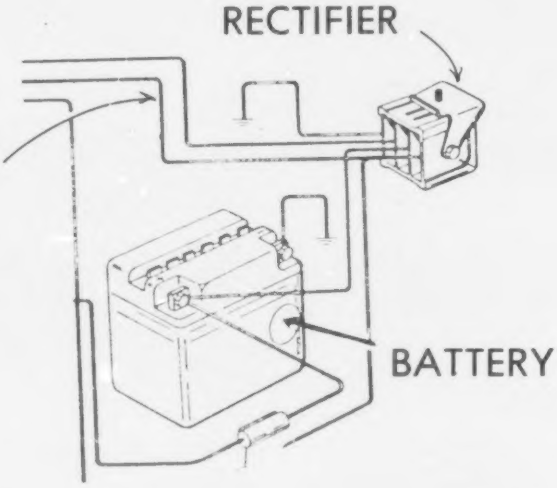
    2. Zener diode

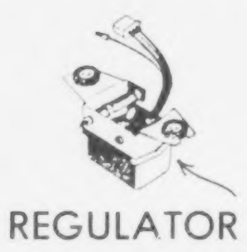
        a. Electronic device that acts as insulator up to a specified voltage and conductor above that voltage

        b. Excess electrical energy converted to heat energy and dissipated to the air by use of a heat sink

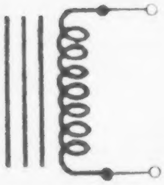
# COMPONENTS OF CHARGING SYSTEM


STATOR PLATE
STATOR COILS
ROTOR OR FLYWHEEL

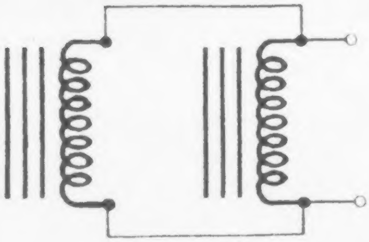

RECTIFIER
CONNECTING WIRES
BATTERY



# SINGLE PHASE COIL CONNECTIONS



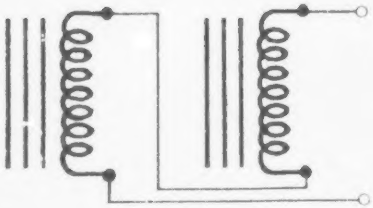
## SINGLE COIL



## PARALLEL CONNECTED

Voltage = Single Coil

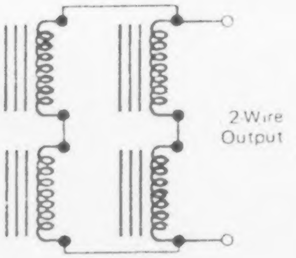
Current = 2X Single Coil



## SERIES CONNECTED

Voltage = 2X Single Coil

Current = Single Coil

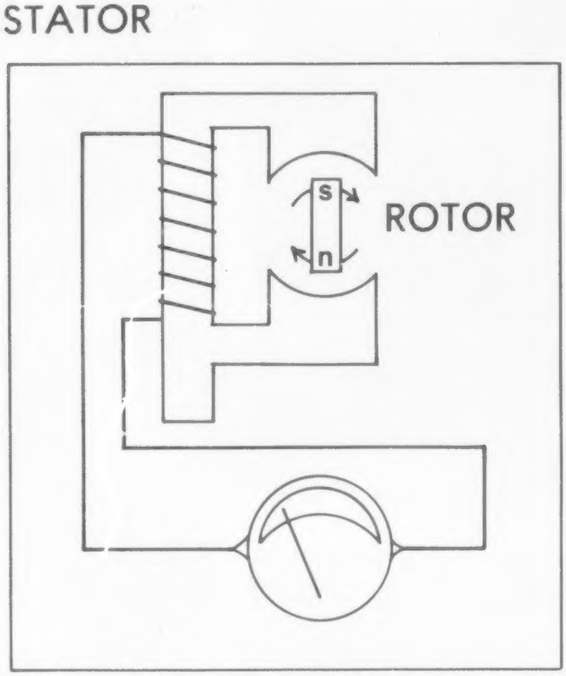


## SERIES-PARALLEL CONNECTED

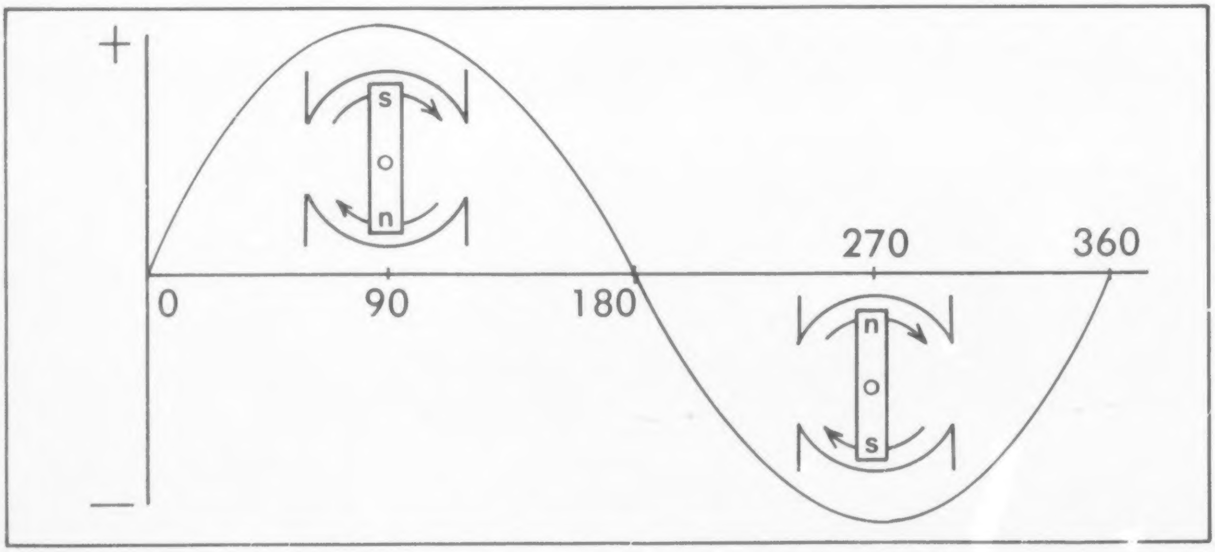
Voltage = 2X Single Coil

Current = 2X Single Coil

# OPERATION OF HALF - WAVE CHARGING SYSTEM


STATOR
s
n
ROTOR

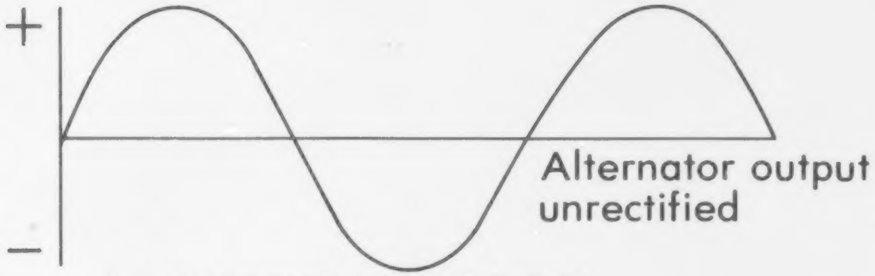
SIMPLE ALTERNATOR (180° - 360°)


+
—
s
o
n
0
90
180
270
360
n
o
s

ALTERNATING CURRENT SINE WAVE

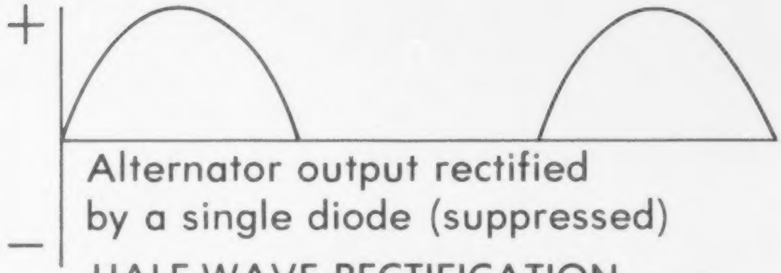
# HALF-WAVE RECTIFICATION

A



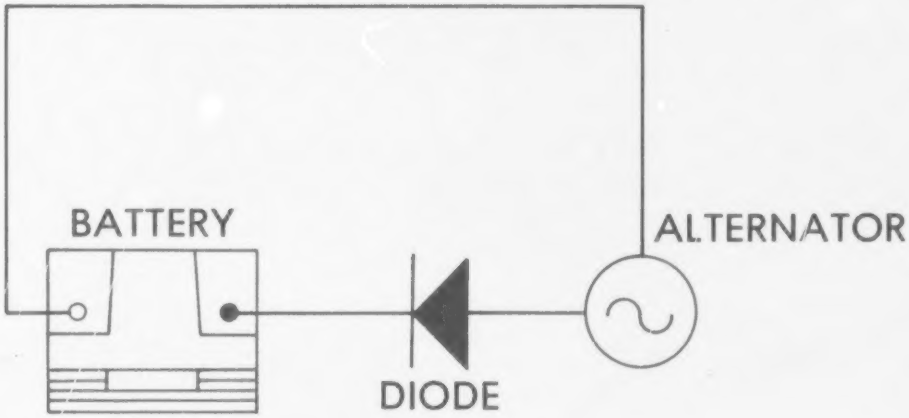
AC CURRENT UNRECTIFIED

B

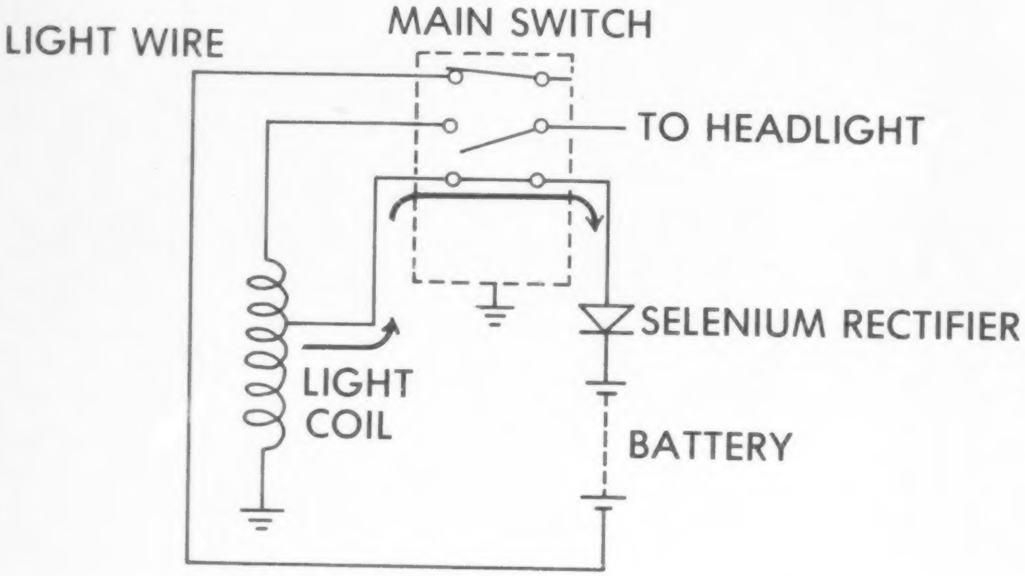


HALF-WAVE RECTIFICATION

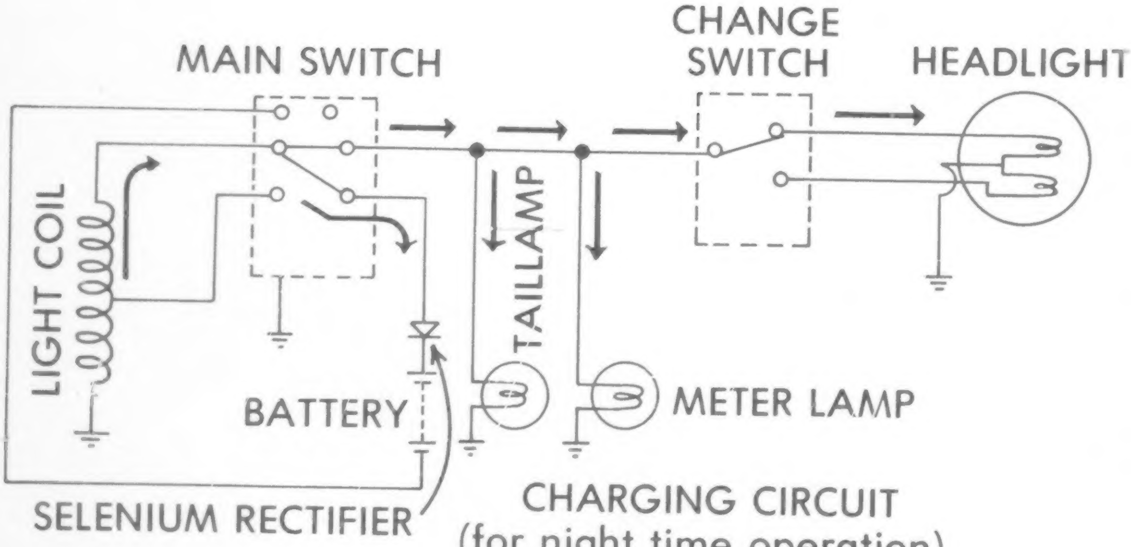
HALF-WAVE RECTIFICATION


BATTERY
ALTERNATOR
DIODE

# SINGLE COIL SYSTEM

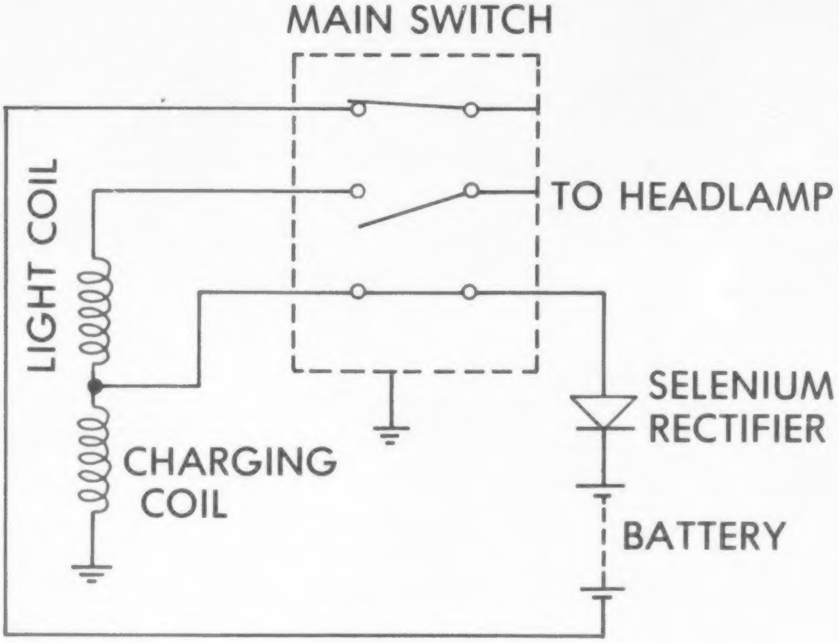

LIGHT WIRE
MAIN SWITCH
TO HEADLIGHT
SELENIUM RECTIFIER
LIGHT
COIL
BATTERY

CHARGING CIRCUIT
(for daytime operation)


MAIN SWITCH
CHANGE
SWITCH
HEADLIGHT
LIGHT COIL
TAILLAMP
BATTERY
METER LAMP
SELENIUM RECTIFIER

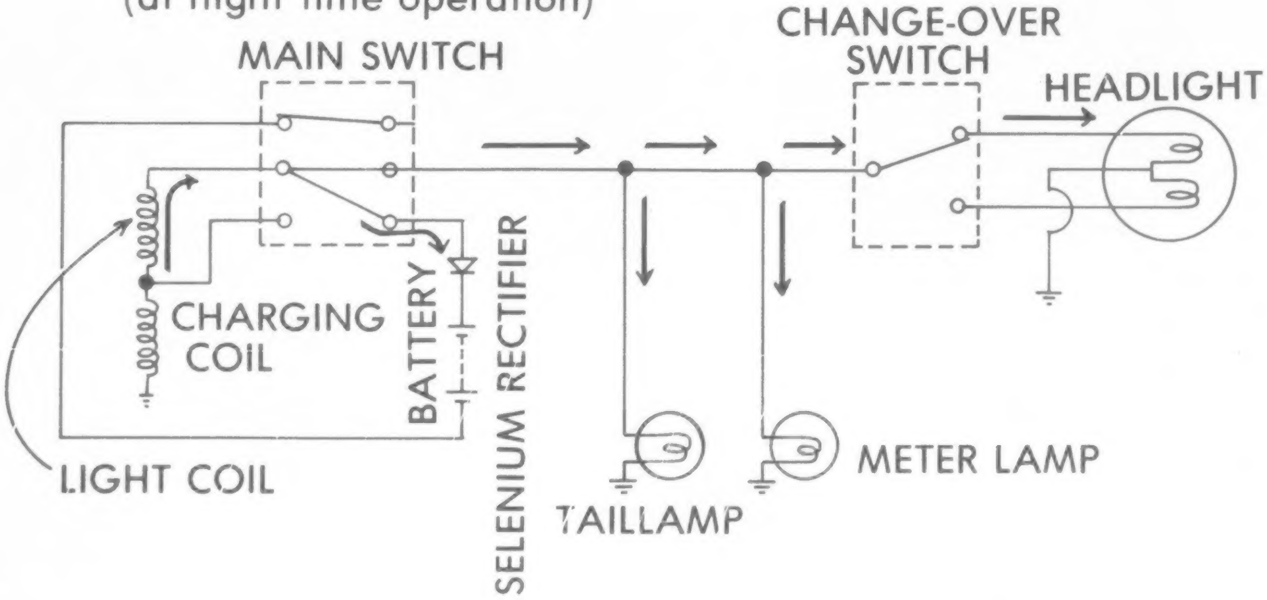
CHARGING CIRCUIT
(for night time operation)

# MULTIPLE COIL SYSTEM


MAIN SWITCH
TO HEADLAMP
LIGHT COIL
SELENIUM RECTIFIER
CHARGING COIL
BATTERY

CHARGING CIRCUIT (daytime)

DIAGRAM OF CHARGING SYSTEM
(at night time operation)


MAIN SWITCH
CHANGE-OVER SWITCH
HEADLIGHT
CHARGING COIL
BATTERY
SELENIUM RECTIFIER
LIGHT COIL
TAILLAMP
METER LAMP

# FULL-WAVE OPERATION – BRIDGE TYPE RECTIFIER AND SCR

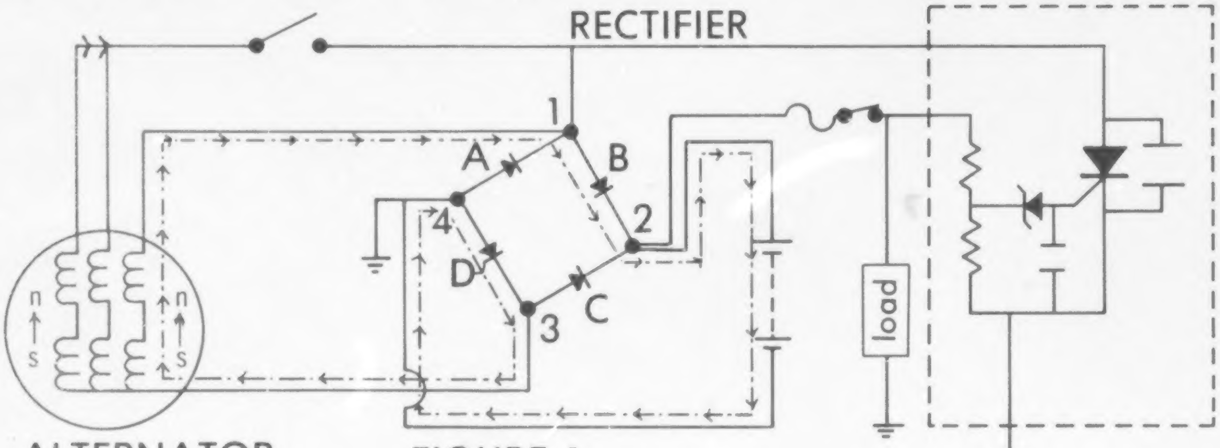

RECTIFIER
1
A
B
4
2
D
3
C
n
s
n
s
load
ALTERNATOR

FIGURE 1

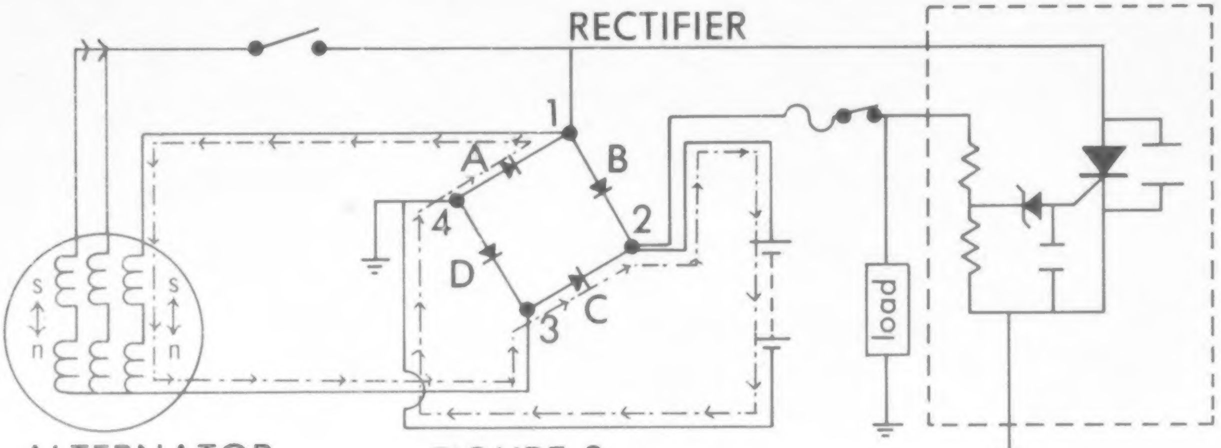

RECTIFIER
1
A
B
4
2
D
C
3
s
n
s
n
load
ALTERNATOR

FIGURE 2

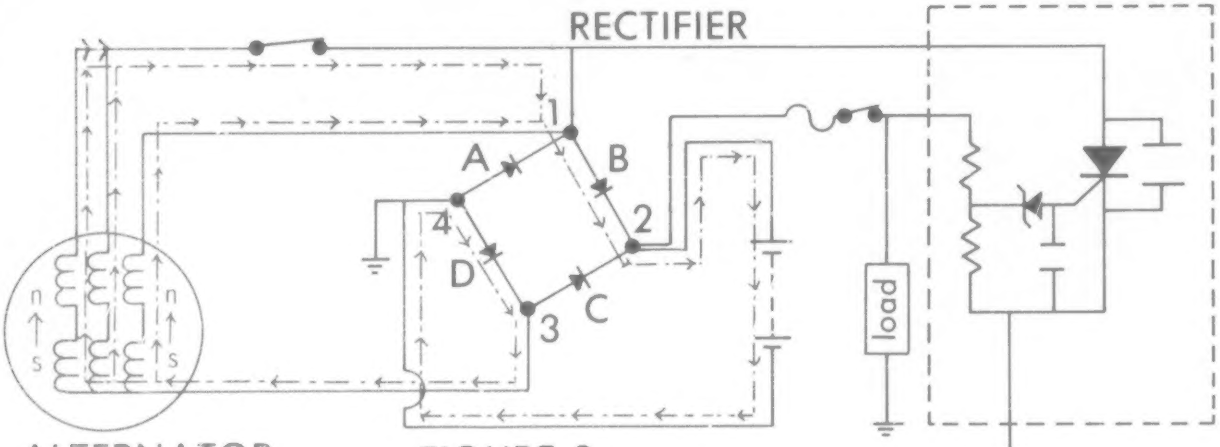
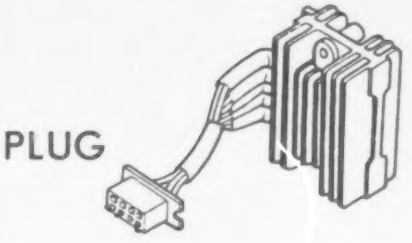
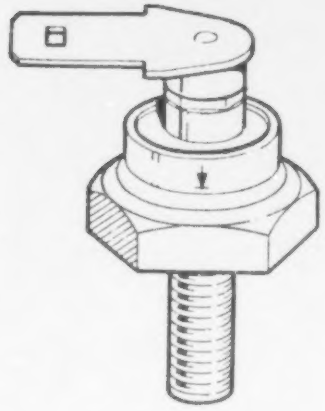

RECTIFIER
1
A
B
4
2
D
3
C
n
s
n
s
load
ALTERNATOR

FIGURE 3

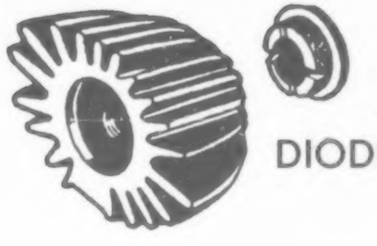
# VOLTAGE REGULATING DEVICES


RECTIFIER
PLUG

SILICON CONTROLLED RECTIFIER



ZENER DIODE



DIODE HEAT SINK

# AC PERMANENT MAGNET SINGLE PHASE CHARGING SYSTEM
## UNIT I

## JOB SHEET #1 TEST DC CHARGING RATE

I. Tools and materials

A. Motorcycle equipped with a permanent magnet charging system

(NOTE: it can be a half-wave or a full-wave system.)

B. DC voltmeter

C. DC ammeter

D. Hand tool assortment

E. Appropriate service manual

F. Safety glasses

II. Procedure

(NOTE: The motorcycle must have a fully charged battery for this test.)

A. Disconnect the rectifier lead from the ungrounded battery terminal

(NOTE: Do not disconnect starter cable if motorcycle is so equipped.)

B. Connect the DC ammeter in series between the disconnected rectifier lead and the battery terminal (Figure 1)

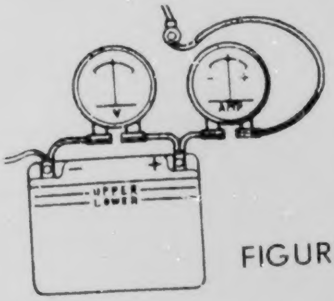


FIGURE 1

C. Connect the DC voltmeter between the disconnected rectifier lead and a good ground

## JOB SHEET #1

D. Start the engine and read the charging amperage and voltage at the different engine speeds as specified in the appropriate service manual (Figure 2)

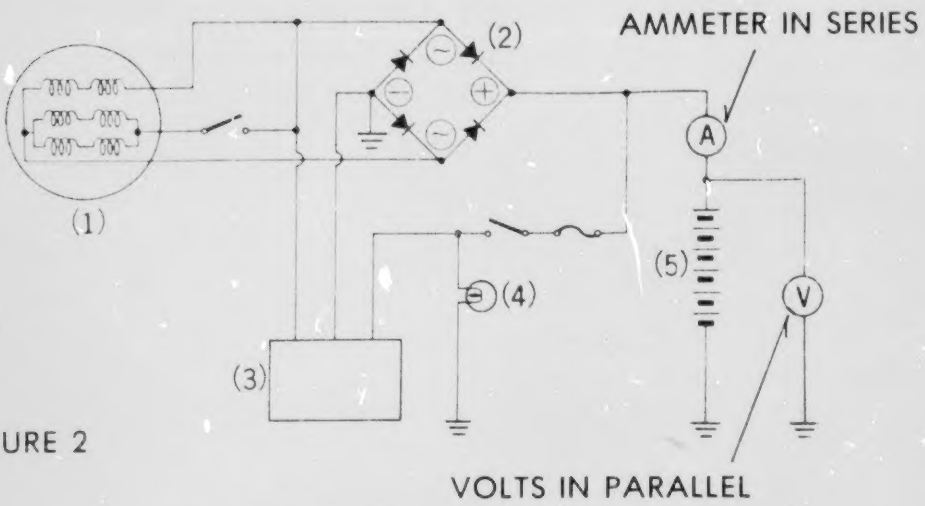

AMMETER IN SERIES
(1)
(2)
(3)
(4)
(5)
A
V
VOLTS IN PARALLEL

FIGURE 2

CHARGING CHARACTERISTICS

E. Take readings in both the day operation and night operation positions

F. Compare all readings with those given in the service manual

## AC PERMANENT MAGNET SINGLE PHASE CHARGING SYSTEM
## UNIT I

### JOB SHEET #2-TEST ALTERNATOR CHARGING AND LIGHTING COILS OUTPUT

I. Tools and materials

A. AC voltmeter or test lamp

B. 1 ohm resistor

C. Hand tool assortment

D. Appropriate service manuals with wiring diagrams

E. Safety glasses

II. Procedure

(NOTE: In order to check the output of the individual coils, it is necessary to locate the respective leads on the wiring diagram so that the separate wires can be isolated. The wires are color coded, but factories are not always consistant in color coding.)

A. Test with AC voltmeter

1. Disconnect the alternator leads at the snap connections and connect an AC voltmeter and a 1 ohm resistor in a parallel with the coil leads (Figure 1)

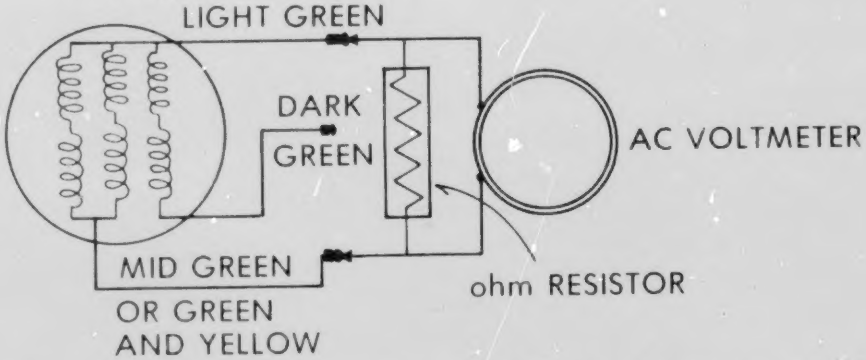


FIGURE 1

2. Start the engine, run at about 3,000 RPM, observe the voltage reading, and compare with service manual specifications

JOB SHEET #2

B. Test with test lamp

(NOTE: A suitable test lamp can be made by soldering two leads to an ordinary automotive light bulb; one lead should be soldered to the bulb case, and the other lead soldered to the bulb contact. Be sure to use a 6 volt lamp for a 6 volt system and a 12 volt lamp for a 12 volt system. See Figure 2.)

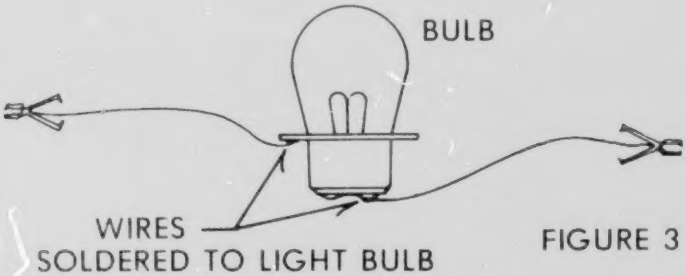

BULB
WIRES
SOLDERED TO LIGHT BULB

FIGURE 3

1. On a full-wave system only one coil can be disconnected and tested at a time (Figure 3)

   (NOTE: If not done in this manner, the return path through the grounding circuit will be open.)

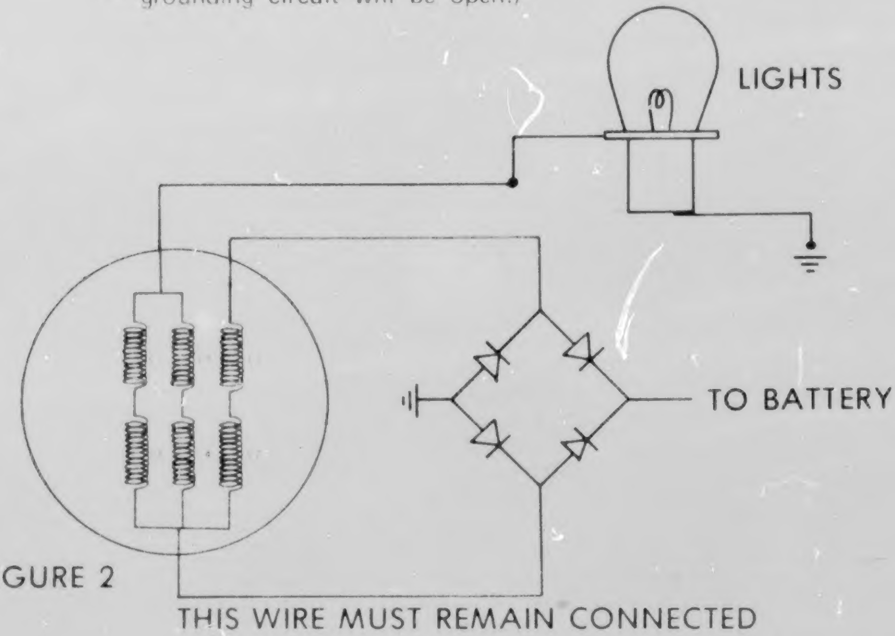

LIGHTS
TO BATTERY
THIS WIRE MUST REMAIN CONNECTED

FIGURE 2

## JOB SHEET #2

2. On a half-wave system both the charging coil and the lighting coil leads can be disconnected at once since the coils are grounded to the stator frame (Figure 4)

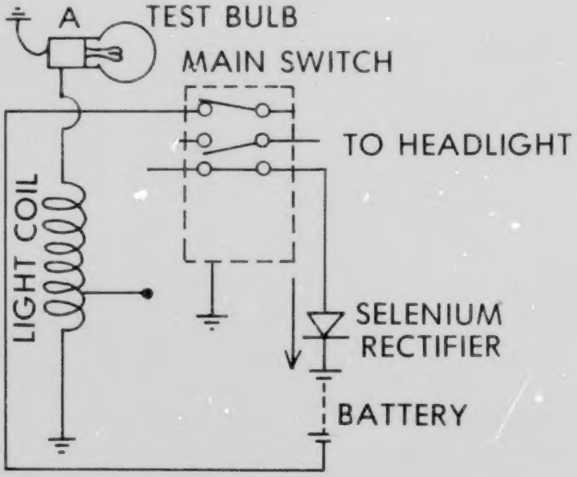

A
TEST BULB
MAIN SWITCH
TO HEADLIGHT
LIGHT COIL
SELENIUM RECTIFIER
BATTERY

FIGURE 4

3. To test the coil output, connect one test lamp lead to a coil lead and the other test lamp lead to a good ground

4. Start the engine and run at about 3,000 RPM; the bulb should light up if the coil is generating current

5. Test each coil in turn (Figure 5)

(NOTE: Any coil that fails to light the bulb is defective.)

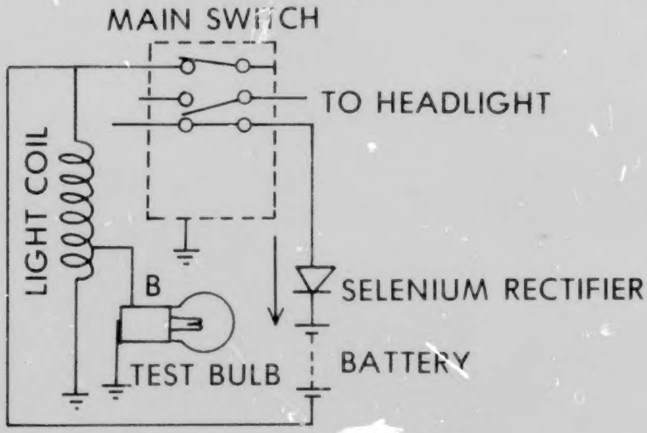

MAIN SWITCH
TO HEADLIGHT
LIGHT COIL
B
SELENIUM RECTIFIER
TEST BULB
BATTERY

FIGURE 5

# AC PERMANENT MAGNET SINGLE PHASE CHARGING SYSTEM
## UNIT I

## JOB SHEET #3--TEST STATOR ASSEMBLY, RECTIFIERS, AND REGULATORS

I. Tools and materials

A. Motorcycle equipped with a zener diode

B. Full-wave and half-wave rectifier

C. SCR regulator

D. Ohmmeter

E. DC voltmeter

F. DC ammeter

G. Hand tool assortment

H. Appropriate service manuals

I. Safety glasses

II. Procedure

A. Bench test stator assembly

(NOTE: When testing coils on a half-wave system the ground lead of the coils must be disconnected.)

1. Test the stator coils for "opens" by connecting an ohmmeter across the coil leads (Figure 1)

(NOTE: Connecting between any two leads should give a very low resistance reading; this indicates an unbroken circuit.)

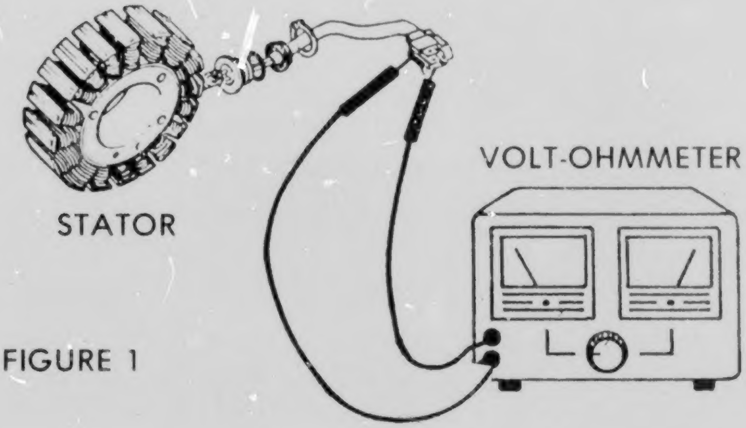


FIGURE 1

## JOB SHEET #3

2. Check the coils for "grounds" by connecting one ohmmeter lead to a coil lead and the other ohmmeter lead to the metal frame or plate (Figure 1)

   (NOTE: The ohmmeter should show no continuity; a low reading would indicate a "ground".)

B. Bench test half-wave rectifier (Figure 2)

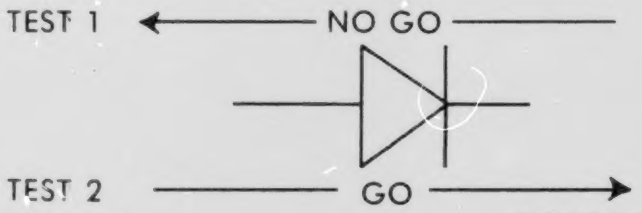


FIGURE 2

1. Test the half-wave rectifier by connecting the ohmmeter leads to the two leads of the rectifier

2. Reverse the leads' connections and test

   (NOTE: The ohmmeter should show a low reading in one direction and a very high resistance reading in the opposite direction; a low or high reading in both directions indicates a faulty rectifier.)

## JOB SHEET #3

C. Bench test full-wave rectifier-with ohmmeter

(NOTE: The bridge or full-wave rectifier consists of 4 diodes, and each one must be tested individually. See Figure 3.)

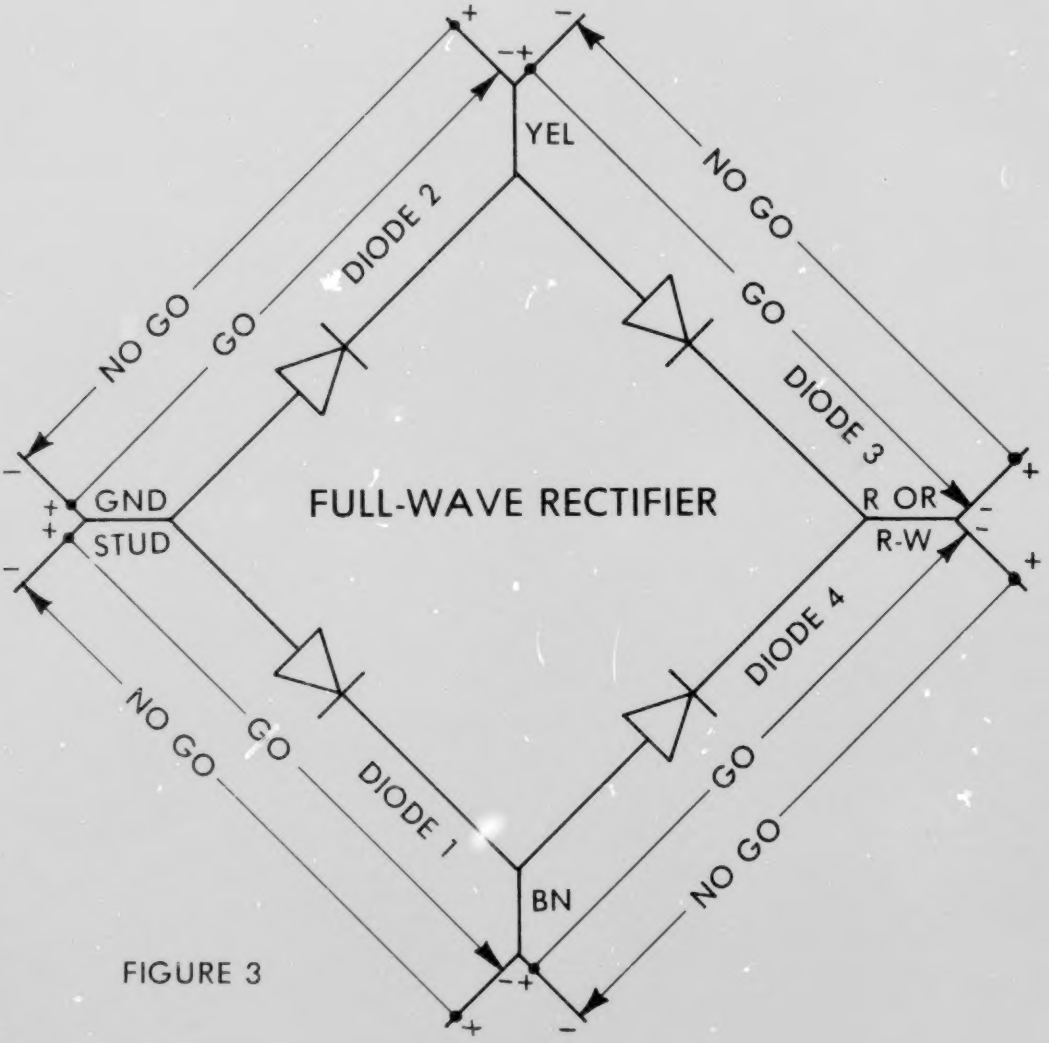

FULL-WAVE RECTIFIER
YEL
GND
STUD
R OR
R-W
BN
DIODE 1
DIODE 2
DIODE 3
DIODE 4
GO
NO GO
+
−

FIGURE 3

## JOB SHEET #3

1. Connect the positive (+) lead of the ohmmeter to the ground stud and the negative (-) lead of the ohmmeter to the brown (common) terminal on diode #1

   (NOTE: The meter should show a low resistance, meaning the current will flow ("GO") in that direction.)

2. Reverse the ohmmeter leads, negative (-) lead to the ground stud and positive (+) lead to the brown (common) terminal on diode #1

   (NOTE: There should be a very high resistance reading, meaning current will not flow ("NO GO") in that direction; a low or high resistance reading in both directions indicates a faulty rectifier.)

3. Repeat the procedure for each of the remaining diodes

   (NOTE: Since color coding varies with different makes and models the appropriate service manual should be consulted to identify the rectifier terminals.)

D. Test full-wave rectifier with voltmeter (Figure 4)

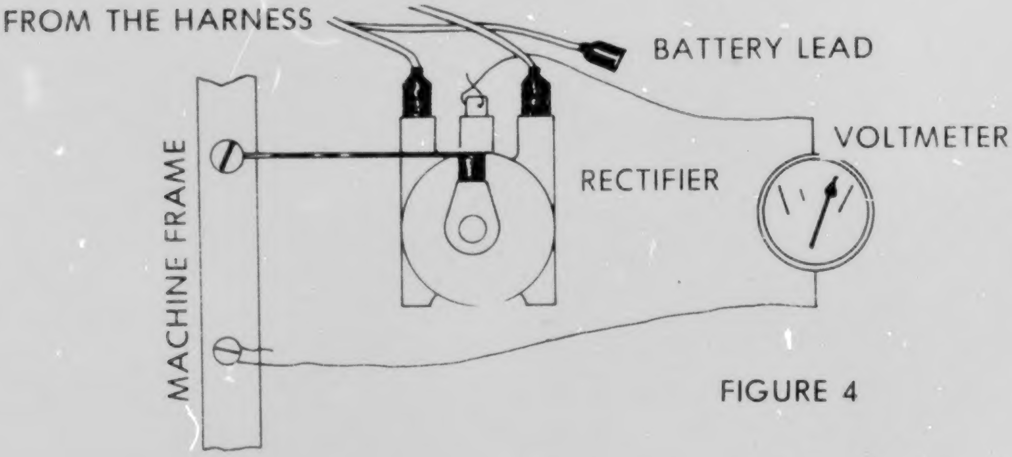


FIGURE 4

1. Disconnect the rectifier to battery lead at the rectifier terminal

2. Connect the voltmeter from the rectifier terminal to a good ground

3. Start the engine and increase the speed to approximately 3,000 RPM

   (NOTE: The voltmeter should read about 7 volts for a 6 volts system and 14 volts for a 12 volt system; a low reading indicates a faulty rectifier.)

## JOB SHEET #3

E. Bench test SCR regulator with ohmmeter (Figure 5)

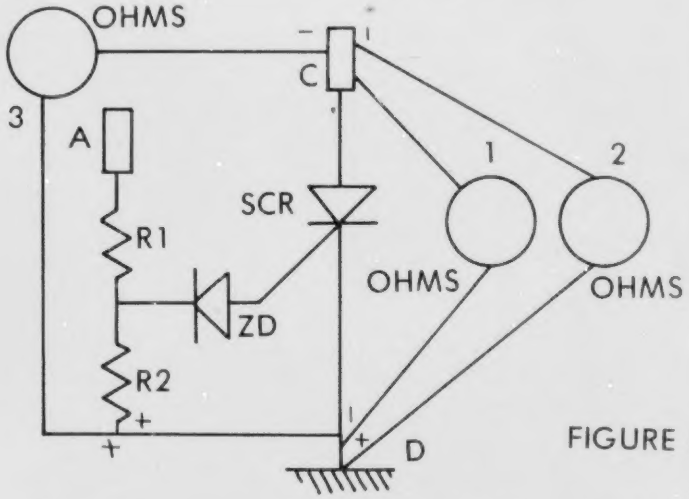


FIGURE 5

1. Check for continuity between points "C" and "D"

   (NOTE: "C" is the input lead from the alternator and "D" is the ground lead of the SCR.)

2. Reverse the ohmmeter leads and check for continuity again

3. Check for continuity between points "C" and the regulator case

   (NOTE: If continuity exists in any of the tests, the regulator should be replaced.)

F. Test SCR regulator with ammeter

1. Connect the ammeter in series with the battery

2. Kick start engine and run at a speed over 2,000 RPM

   (NOTE: If ammeter indicates a discharge, disconnect the input lead from the alternator to the regulator. If charging is restored, regulator is faulty.)

## JOB SHEET #3

G. Test zener diode with ammeter and voltmeter (Figure 6)

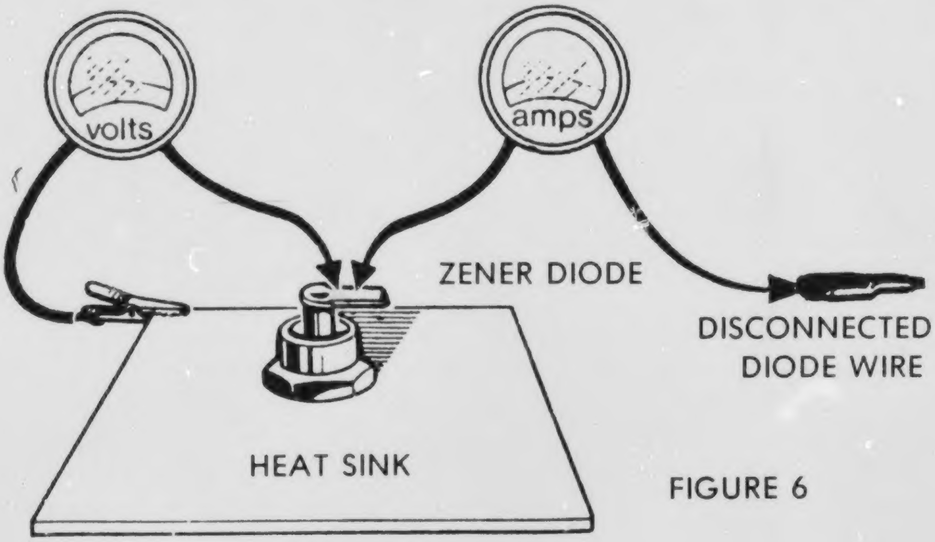


FIGURE 6

1. Connect the positive lead of the ammeter to the diode terminal and the negative lead to the diode wire
2. Connect the positive lead of the voltmeter to ground and the negative lead to the diode terminal
3. Start engine and increase speed to approximately 3,000 RPM and note the readings

   (NOTE: As the system voltage rises to approximately 12.75 volts, there should be no reading on the ammeter; above approximately 12.75 volts a reading should start on the ammeter. When the ammeter rises to 2 amps, the voltmeter should read between 13.5 and 15.5 volts. If the readings do not come within this specification, the diode must be replaced.)

# AC PERMANENT MAGNET SINGLE PHASE CHARGING SYSTEM
## UNIT I

NAME ____________________

## TEST

1. Match the terms on the right to the correct definitions.

_____a. Semiconducting material used as a rectifier on older motorcycles

_____b. Device that allows a current to pass through in only one direction

_____c. Alternator with permanent magnets used to generate current for an internal combustion engine

_____d. Diode that will flow current in a reverse direction when a reverse directional voltage of a predetermined value is applied

_____e. Current produced in a conductor when moved through a magnetic field

_____f. Stationary coils of an alternator

_____g. Device in the charging system that changes alternating current (AC) to direct current (DC)

_____h. Stator coil (or coils) used to produce current to operate the lights

_____i. Generator that uses a revolving magnet and stationary stator windings to produce alternating current

_____j. Rotating part of an alternator which contains permanent magnets

_____k. Semiconducting material used in the construction of diodes

_____l. Electronically controlled switch that acts as a voltage regulator in the charging system

_____m. Device to limit the output of the alternator and prevent overcharging of the battery

_____n. Device for the absorption of unwanted heat

1. Zener diode
2. Rectifier
3. Stator
4. Silicon controlled rectifier (SCR)
5. Selenium
6. Alternator
7. Silicon
8. Regulator
9. Diode
10. Rotor
11. Magneto
12. Lighting coil
13. Magnetic induction
14. Heat sink

2. Select the components of the AC permanent magnet single phase charging system by placing an "X" in the appropriate blanks.

_____a. Stator assembly (charging and lighting coils)

_____b. Pulse damper

_____c. Regulator

_____d. Condenser

_____e. Rectifier

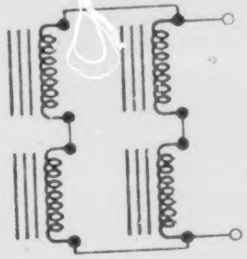
_____f. Battery

_____g. Spark plug

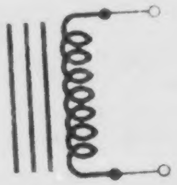
_____h. Rotor (or flywheel)

_____i. Connecting wires

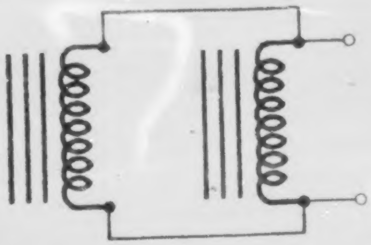
3. Identify the types of single phase coil connections.



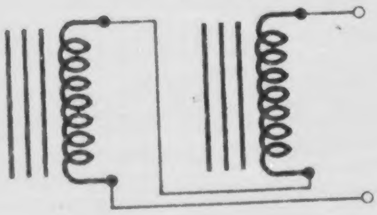
a. ____________________



b. ____________________



c. ____________________



d. ____________________

4. Distinguish between the two types of charging systems by placing an "X" next to the description of the full-wave charging system.

______a. Allows only one half of the generated current, only positive waves, to pass to the battery

______b. Allows all of the generated current, both positive and negative waves, to pass to the battery

5. Describe the operation of the half-wave charging system.

6. Describe the operation of the full-wave charging system.

7. Demonstrate the ability to:

   a. Test DC charging rate.

   b. Test alternator charging and lighting coils output.

   c. Test stator assembly, rectifiers, and regulators.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

# AC PERMANENT MAGNET SINGLE PHASE CHARGING SYSTEM
## UNIT I

## ANSWERS TO TEST

1.
   a. 5
   b. 9
   c. 11
   d. 1
   e. 13
   f. 3
   g. 2
   h. 12
   i. 6
   j. 10
   k. 7
   l. 4
   m. 8
   n. 14

2. a, c, e, f, h, i

3.
   a. Series-parallel connected
   b. Single coil
   c. Parallel connected
   d. Series connected

4. b

5. Description should include:
   a. Current produced is alternating current
      1) Suitable for lighting
      2) Not suitable for charging DC battery
   b. Rotor with cast-in magnets rotates past stator and lighting coils
      1) Rotor moves 180°
         a) Magnetic field of north pole moves across coil
         b) Current is induced in coil
         c) Current flows in one direction represented by sine wave rising above neutral or horizontal line
         d) Positive voltage

2) Rotor moves another 180°

   a) Magnetic field of south pole moves across coil

   b) Current is induced in coil

   c) Current flows in opposite direction represented by sine wave dropping below neutral or horizontal line

   d) Negative voltage

c. Diode used to rectify current

   1) Allows positive wave (current) to pass

   2) Does not allow negative wave (current) to pass

   3) Only 1/2 of total waves (currents) pass to battery

   4) Current moves in the same direction thus becoming DC

d. Electrical needs vary

   1) Day-Charge battery only

      a) 1/2 of the coils of a multiple coil system

      b) 1/2 of the coil of a single coil system

   2) Night-Charge battery and operate lights

      a) All coils of a multiple coil system

         (1) 1/2 of the coils to charge battery

         (2) 1/2 of the coils to power lights

      b) Both halves of a single coil system

         (1) 1/2 of the coil to charge battery

         (2) 1/2 of the coil to power lights

6. Description should include:

   a. System uses both positive and negative waves to charge the battery

   b. Two types of full-wave systems

      1) Connect or disconnect additional stator coils for day or night use

         a) Similar to half-wave system

         b) Voltage regulator may or may not be used

2) All coils permanently connected into circuit

   a) Engine speed determines alternator output

   b) Requires voltage regulating devices

      (1) Silicon controlled rectifier

      (2) Zener diode

c. Bridge type rectifier used to change AC to DC

1) Magnets pass north to south past the coils causing positive current to flow

   a) From coils to terminal 1 of rectifier

   b) Through diode B to terminal 2

   c) From terminal 2 through battery back to terminal 4 or grounded side of rectifier

   d) Through diode D to terminal 3 and back to coils to complete circuit

2) Magnets pass south to north past the coils causing negative current to flow

   a) From coils to terminal 3 of rectifier

   b) Through diode 3 to terminal 2

   c) From terminal 2 through battery back to terminal 4 or grounded side of rectifier

   d) Through diode A to terminal 1 and back to coils to complete circuit

3) Both the positive and the negative waves of current pass through the battery in the same direction

d. Voltage regulation

1) Silicon controlled rectifier (SCR)

   a) Electronic switch activated when voltage across the battery terminals is high enough to cause damage to battery and other electrical units

   b) Allows charging current to by pass battery and return to alternator

2) Zener diode

a) Electronic device that acts as insulator up to a specified voltage and conductor above that voltage

b) Excess electrical energy converted to heat energy and dissipated to the air by use of a heat sink

7. Performance skills evaluated to the satisfaction of the instructor

# AC ELECTROMAGNETIC THREE PHASE CHARGING SYSTEM
## UNIT II

## UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms and definitions associated with AC electromagnetic three phase charging systems and list the components of this system. The student should also be able to describe the operation of the three phase system and perform the tests and service on the system. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with AC electromagnetic three phase charging systems to the correct definitions.
2. Select the major components of the electromagnetic three phase charging system.
3. Identify the types of three phase coil connections.
4. Match the types of three phase alternator designs to the correct design characteristics.
5. Select the circuits used in the AC electromagnetic three phase charging system.
6. Describe the operation of the alternator.
7. Describe the operation of the mechanical voltage regulator.
8. Demonstrate the ability to:
    a. Test the DC charging rate.
    b. Bench test field coils, stator assembly, and rectifier.
    c. Check and adjust voltage regulator.

# AC ELECTROMAGNETIC THREE PHASE CHARGING SYSTEM
# UNIT II

## SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss the procedures outlined in the job sheets.

  G. Give test.

II. Students:

  A. Read objective sheet.

  B. Study information sheet.

  C. Complete job sheets.

  D. Complete activities assigned by instructor.

  E. Take test.

## INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Three Phase Sine Waves

    2. TM 2--Major Components of Three Phase AC Charging System

    3. TM 3--Three Phase Coil Connections

4. TM 4--Three Phase Alternator Designs
5. TM 5--Mechanical Voltage Regulators
6. TM 6--Regulator Mode 1
7. TM 7--Regulator Mode 2
8. TM 8--Regulator Mode 3

D. Job sheets

1. Job Sheet #1--Test DC Charging Rate
2. Job Sheet #2--Bench Test Field Coils, Stator Assembly, and Rectifier
3. Job Sheet #3--Check and Adjust Voltage Regulator

E. Test

F. Answers to test

II. References:

A. *Honda Motorcycle and Power Products Training Manual.* Gardena, California: American Honda Motor Co., Inc., 1975.

B. *Motorcycle Systems Training Manual-Motorcycle Electrical Circuits.* P/N 99995-447. Kawasaki Motors Corp., 1973.

C. *Honda CB 750 Service Manual.* Honda Motor Co., Ltd., 1971.

D. *Suzuki Electrical Systems and Accessories Training Handouts.* U.S. Suzuki Technical Training Centers. Suzuki Motor Co., Ltd.

E. *Suzuki GT 550 Service Manual.* Suzuki Motor Co., Ltd., 1973.

## AC ELECTROMAGNETIC THREE PHASE CHARGING SYSTEM
## UNIT II

### INFORMATION SHEET

I. Terms and definitions

   A. Three phase--Alternator system in which the wave forms are 120° apart per revolution of a single magnetic field (Transparency 1)

   B. Field coil--Coil of wire through which battery current flows to establish an electromagnetic field for use in the induction process

   C. Slip rings--Brass rings on the rotor shaft which contact the brushes and are used to conduct current into and out of the rotating field coils

      (NOTE: Slip rings are only used on rotating field coils.)

   D. Electromagnet--Core of magnetic material surrounded by a coil of wire through which an electrical current is passed to magnetize the core

II. Major components of electromagnetic three phase charging system (Transparency 2)

   A. Rotor

   B. Field coil

   C. Stator coils

   D. Alternator housing

   E. Voltage regulator

   F. Rectifier (six diode)

   G. Battery

III. Types of three phase coil connections (Transparency 3)

   A. Delta connected

   B. WYE connected

## INFORMATION SHEET

IV. Types of three phase alternator designs (Transparency 4)

- A. Rotating field coil
    1. Field coil is wound around the rotor between the pole pieces
    2. Rotor turns inside of stator assembly
    3. Slip rings and brushes used to transmit current to field coil
- B. Stationary field coil
    1. Field coil and stator windings both attached to alternator cover
    2. Pole pieces of rotor rotate between stator and field coils

V. Circuits used in AC electromagnetic three phase charging system

- A. Field circuit
- B. Charging circuit
- C. Regulator relay coil circuit

VI. Operation of alternator

- A. Moving magnetic field needed to produce current
    1. Battery voltage passed through field coil to create magnetic field
    2. Magnetic field set into motion when engine is started
    3. AC voltage induced in stator coils
- B. Change to DC
    1. Current is changed from AC to DC as it passes through rectifier
    2. DC charges battery

## INFORMATION SHEET

VII. Operation of mechanical voltage regulator (Transparency 5)

- A. Mode 1 (Transparency 6)
    1. Battery voltage low
    2. Low current to regulator relay coil
        - a. No magnetic field produced
        - b. Armature pulled up by spring
    3. Armature touching upper contact points
    4. Alternator field coil current
        - a. Does not pass through resistors
        - b. Amperage is 1.6 amps
    5. High field coil current produces strong magnetic field
    6. High alternator output
- B. Mode 2 (Transparency 7)
    1. Battery voltage normal
    2. Higher current to regulator relay coil
        - a. Moderate magnetic field is produced
        - b. Armature now midway between upper and lower contacts
    3. Armature not touching either upper or lower contact points
    4. Alternator field coil current
        - a. Passes through 10 ohm resistor
        - b. Amperage is 0.7 amps
    5. Weak field coil current produces weak magnetic field
    6. Lower alternator output

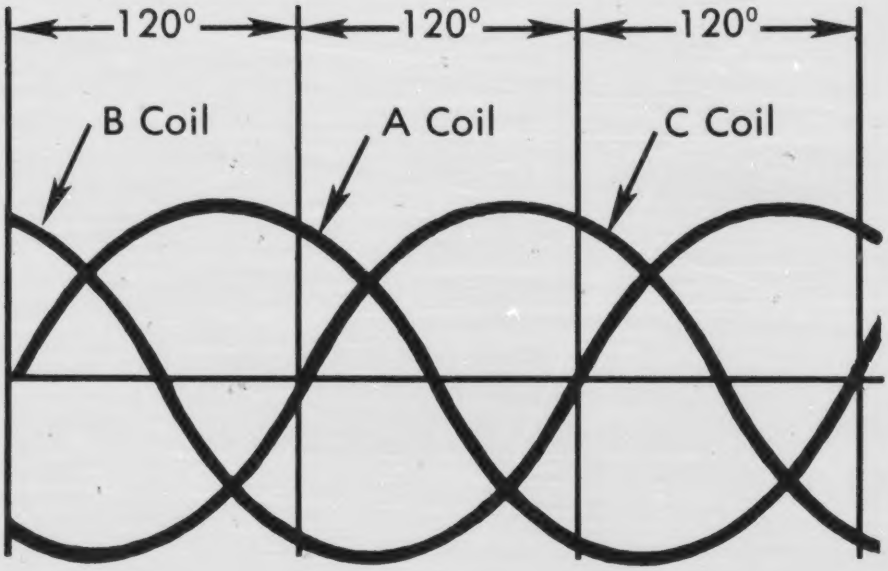
# INFORMATION SHEET

C. Mode 3 (Transparency 8)

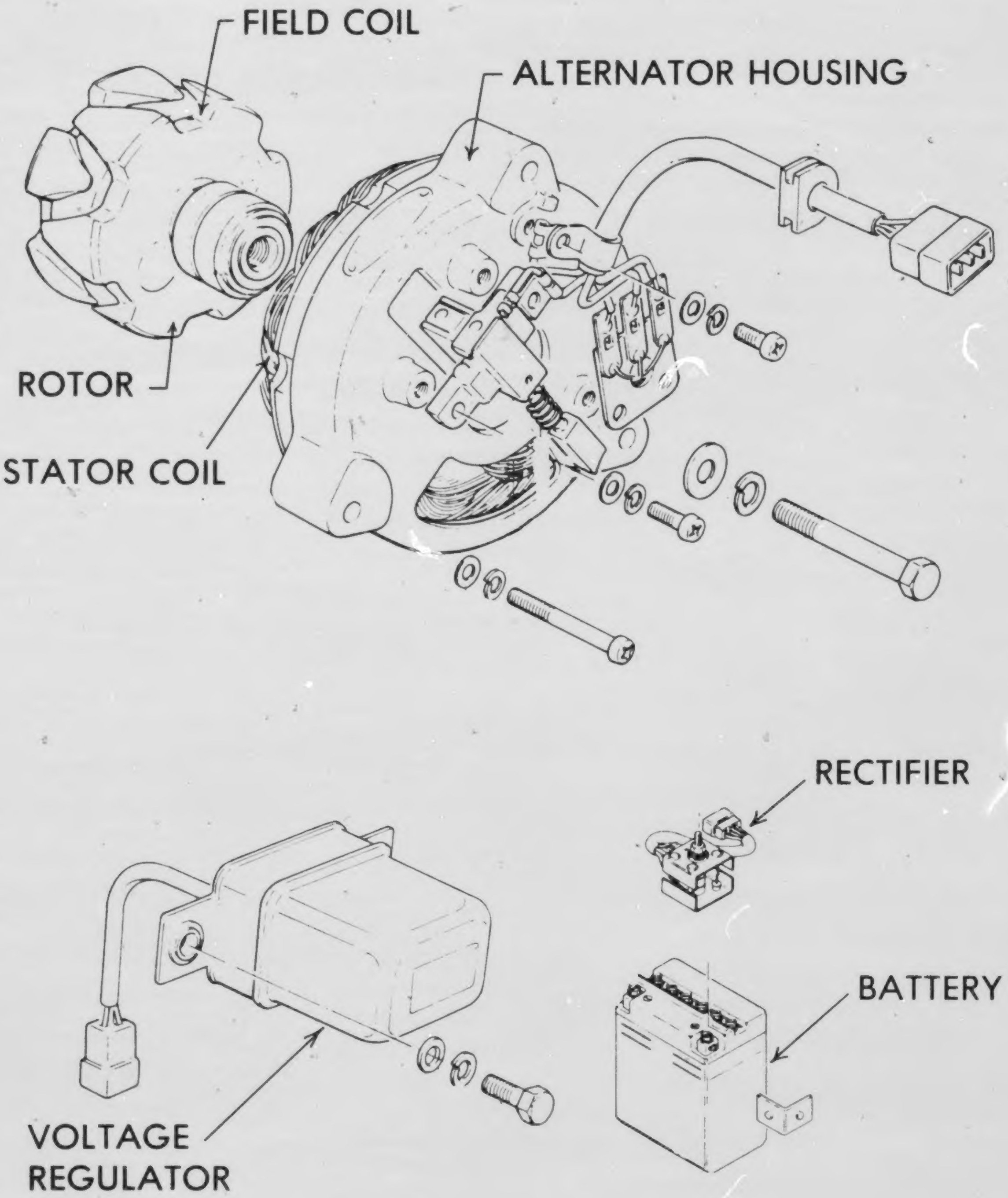
1. Battery voltage high
2. High current to regulator relay coil
    a. Strong magnetic field produced
    b. Armature pulled down by magnetic field
3. Armature touching lower contact points
4. Alternator field coil current
    a. Passes through 10 ohm resistor
    b. Through lower contacts to ground
    c. Amperage is 0
5. No field coil current produces no magnetic field
6. No alternator output

(NOTE: In actual operation the movable contact arm is moving up and down at a very high frequency and thus holds the battery voltage at a constant level.)

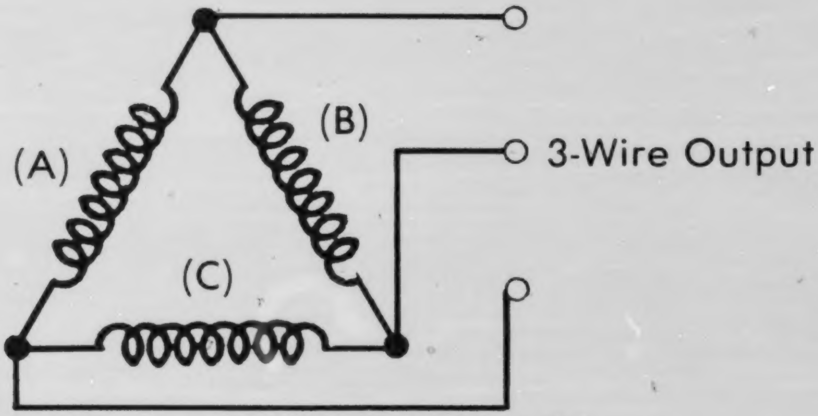
# THREE PHASE SINE WAVES


120°
120°
120°
B Coil
A Coil
C Coil

# MAJOR COMPONENTS OF THREE PHASE AC CHARGING SYSTEM


FIELD COIL
ALTERNATOR HOUSING
ROTOR
STATOR COIL
RECTIFIER
BATTERY
VOLTAGE REGULATOR

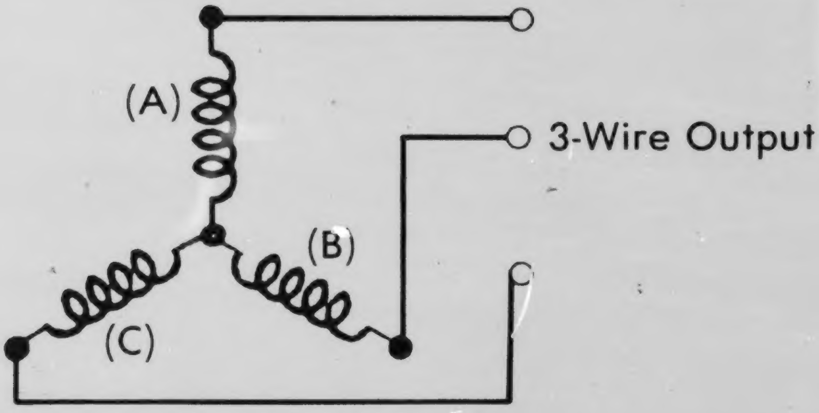
# THREE PHASE COIL CONNECTIONS


(A)
(B)
(C)
3-Wire Output

DELTA CONNECTED (3 PHASE)

Voltage = Single Coil

Current = 1.73 X Single Coil

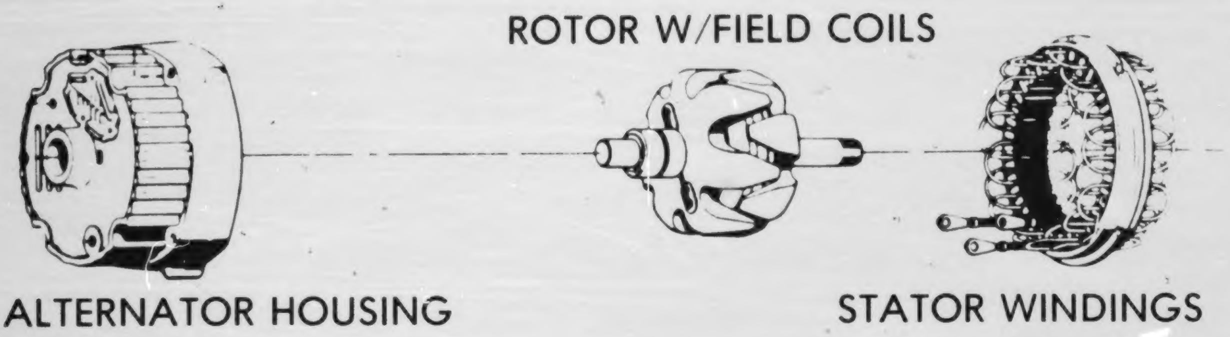

(A)
(B)
(C)
3-Wire Output

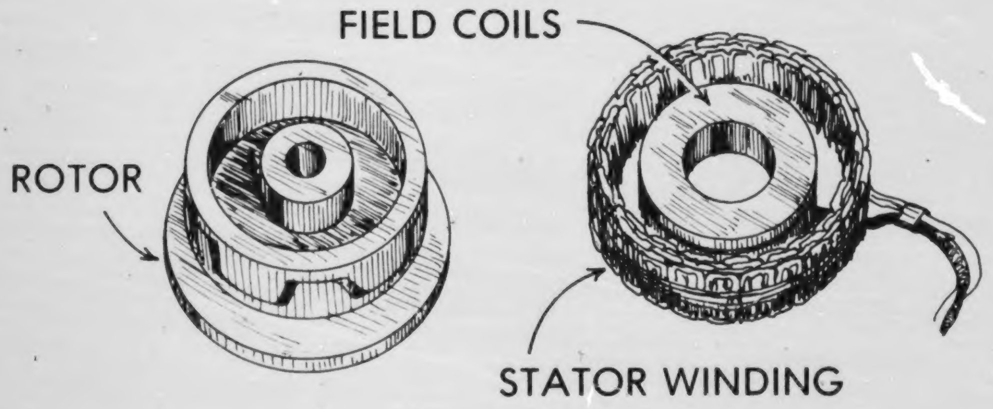
WYE CONNECTED (3 PHASE)

Voltage = 1.73 X Single Coil

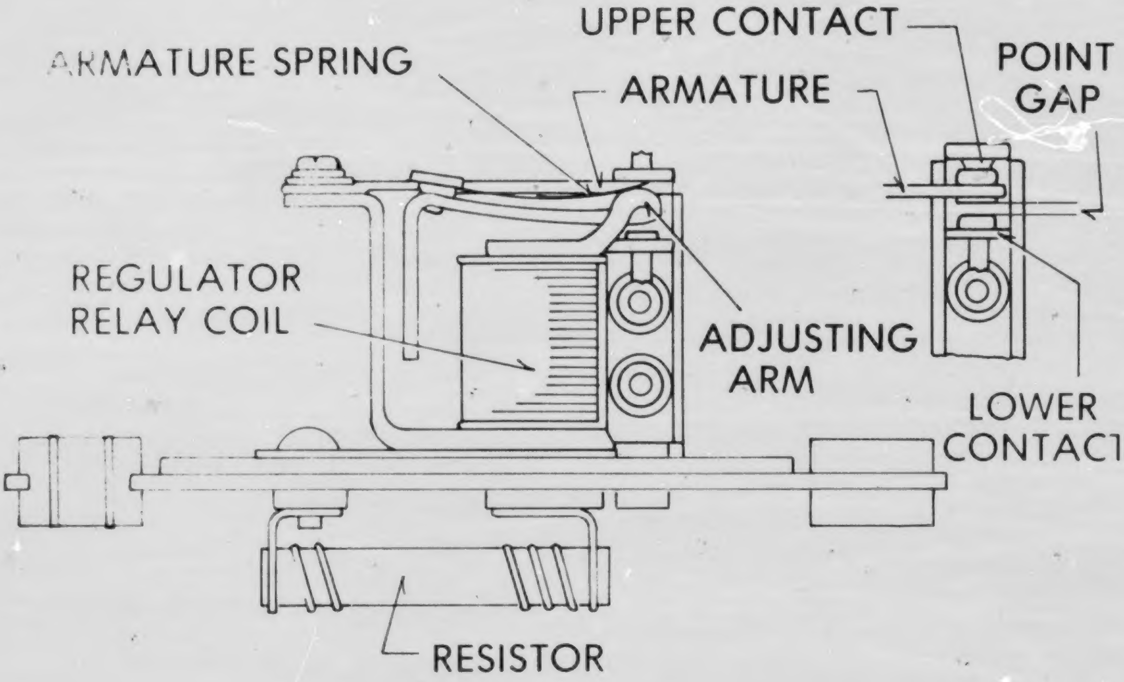
Current = Single Coil

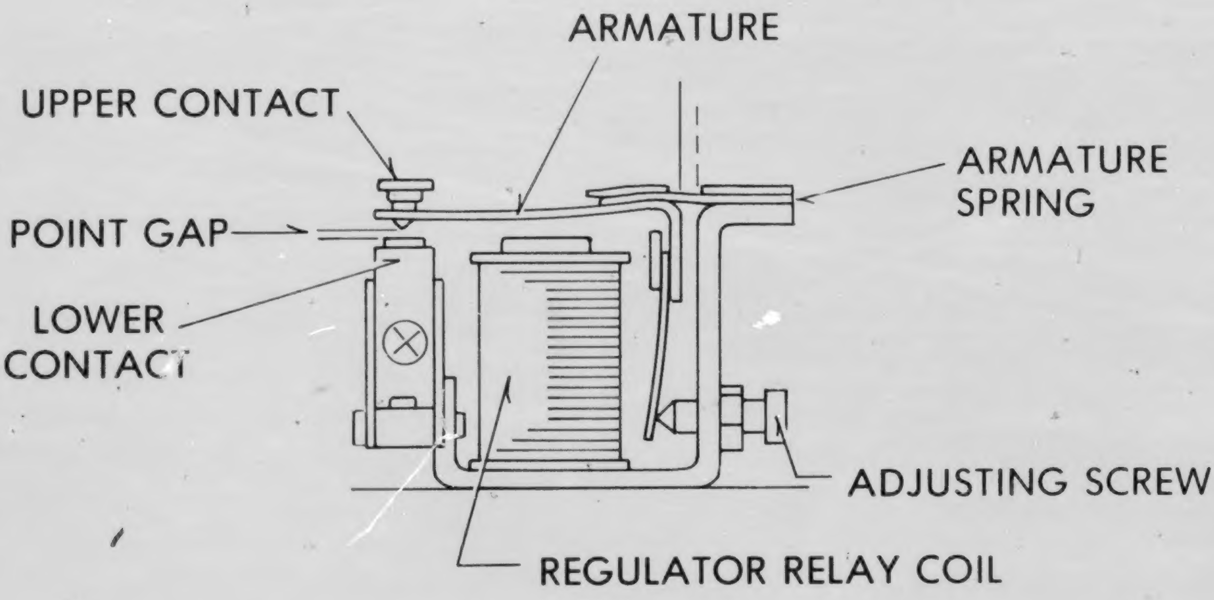
# THREE PHASE ALTERNATOR DESIGNS


ROTOR W/FIELD COILS
ALTERNATOR HOUSING
STATOR WINDINGS

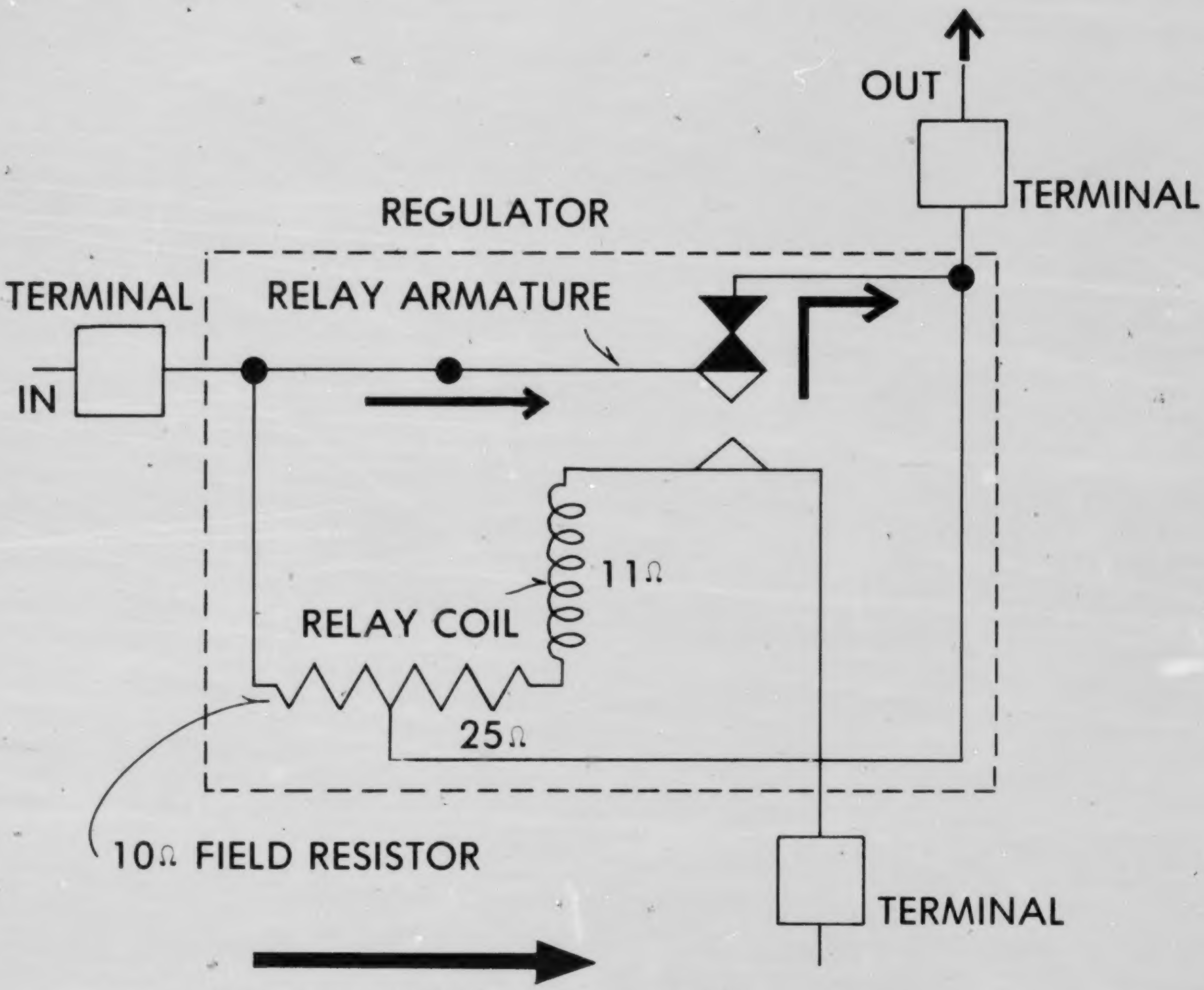

FIELD COILS
ROTOR
STATOR WINDING

# MECHANICAL VOLTAGE REGULATORS


UPPER CONTACT
ARMATURE SPRING
ARMATURE
POINT GAP
REGULATOR RELAY COIL
ADJUSTING ARM
LOWER CONTACT
RESISTOR

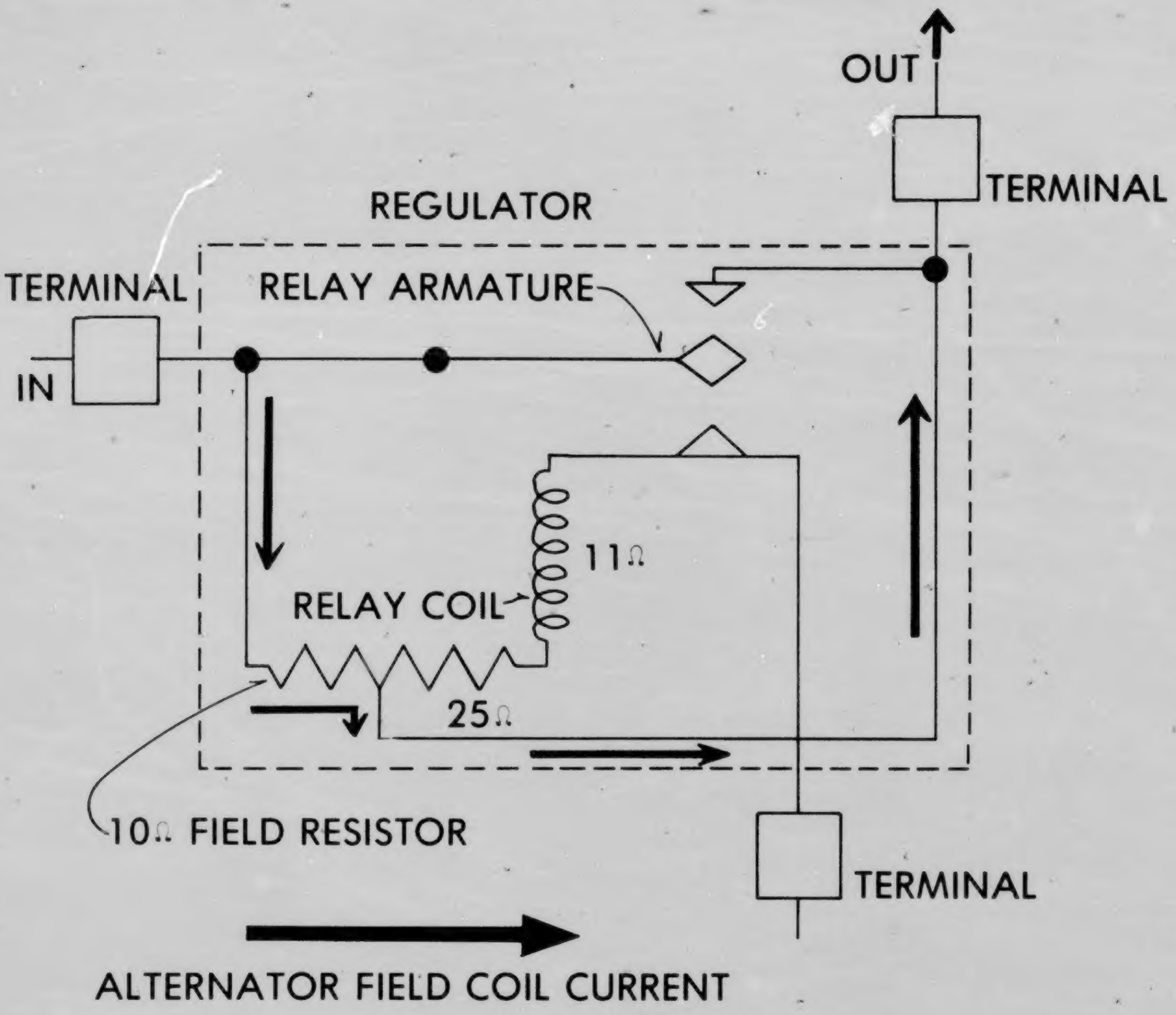

ARMATURE
UPPER CONTACT
ARMATURE SPRING
POINT GAP
LOWER CONTACT
ADJUSTING SCREW
REGULATOR RELAY COIL

# REGULATOR MODE 1

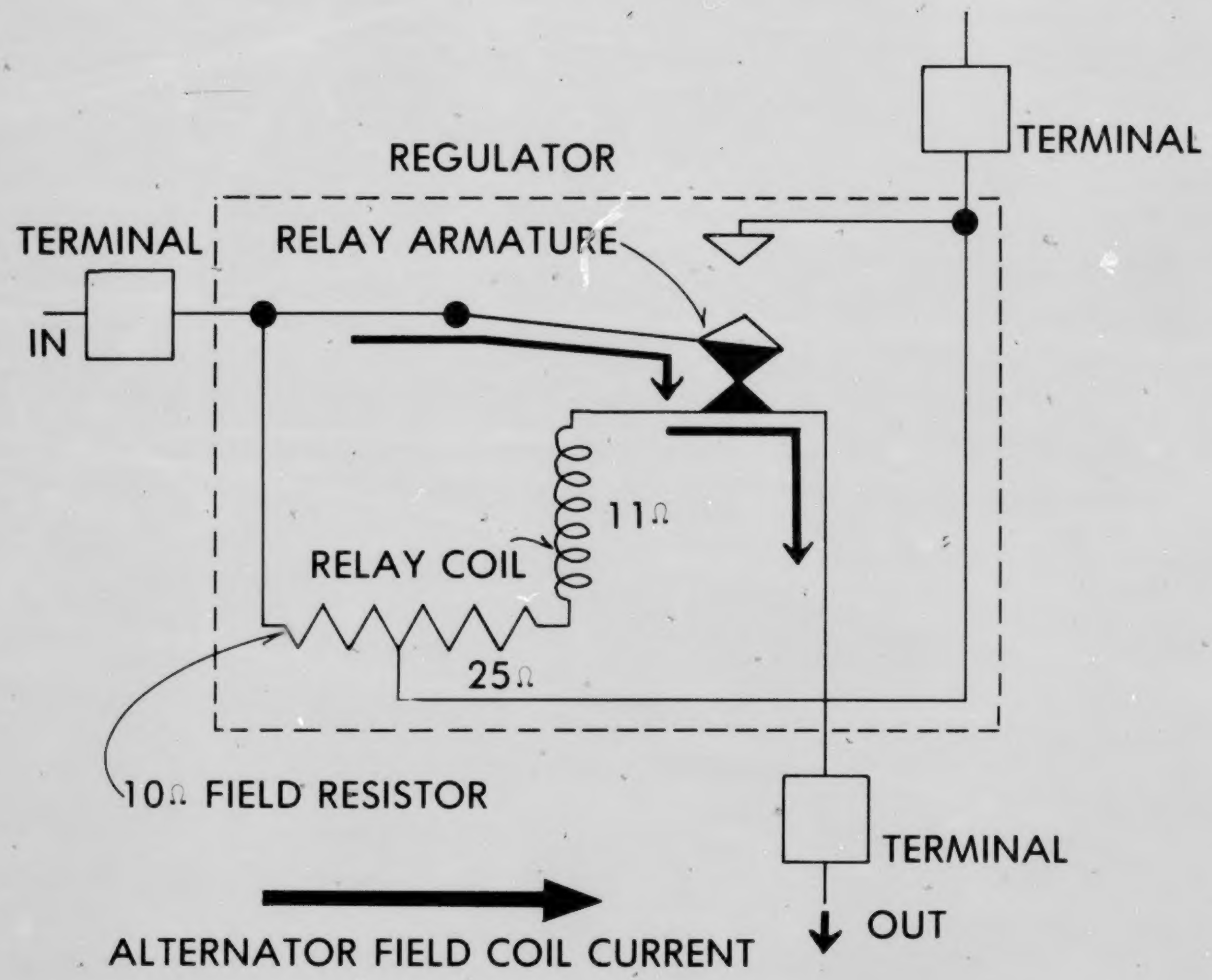

OUT
TERMINAL
REGULATOR
TERMINAL
RELAY ARMATURE
IN
11Ω
RELAY COIL
25Ω
10Ω FIELD RESISTOR
TERMINAL

ALTERNATOR FIELD COIL CURRENT

# REGULATOR MODE 2


OUT
TERMINAL
REGULATOR
TERMINAL
RELAY ARMATURE
IN
11Ω
RELAY COIL
25Ω
10Ω FIELD RESISTOR
TERMINAL
ALTERNATOR FIELD COIL CURRENT

# REGULATOR MODE 3


REGULATOR
TERMINAL
TERMINAL
IN
RELAY ARMATURE
11Ω
RELAY COIL
25Ω
10Ω FIELD RESISTOR
TERMINAL
OUT
ALTERNATOR FIELD COIL CURRENT

# AC ELECTROMAGNETIC THREE PHASE CHARGING SYSTEM
## UNIT II

## JOB SHEET #1--TEST DC CHARGING RATE

I. Tools and materials

- A. Motorcycle equipped with a three phase charging system
- B. DC voltmeter
- C. DC ammeter
- D. Hand tool assortment
- E. Appropriate service manual
- F. Safety glasses

II. Procedure

(NOTE: The motorcycle must have a fully charged battery before this test.)

- A. Disconnect the rectifier lead from the battery terminal (usually the + terminal)
- B. Connect the DC ammeter in series between the disconnected rectifier lead and the battery
- C. Connect a DC voltmeter in parallel from the disconnected rectifier lead to a good ground
- D. Start the engine and take test readings
  - 1. With switches set for night operation
    - a. Operate the engine at the speeds recommended by the manufacturer
    - b. Compare the amperage and voltage reading with the service manual specifications
  - 2. With switches set for day operation
    - a. Operate the engine at the speeds recommended by the manufacturer
    - b. Compare the amperage and voltage readings with the service manual specifications

(NOTE: Readings considerably different from those recommended indicate problems in the charging system.)

# AC ELECTROMAGNETIC THREE PHASE CHARGING SYSTEM
## UNIT II

## JOB SHEET #2--BENCH TEST FIELD COILS, STATOR ASSEMBLY, AND RECTIFIER

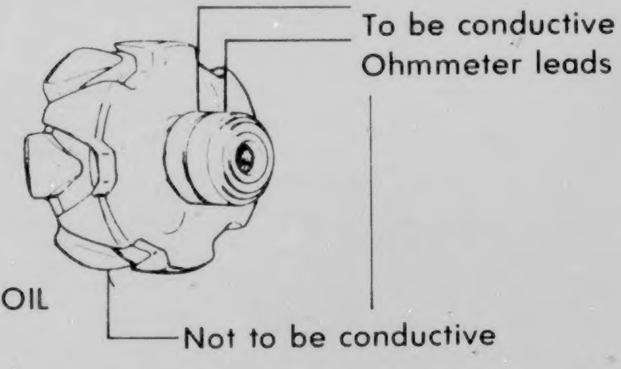
I. Tools and materials

- A. Assortment of field coils--Rotating type or stationary type
- B. Assortment of stator assemblies and three phase rectifiers
- C. Ohmmeter
- D. Appropriate service manuals
- E. Safety glasses

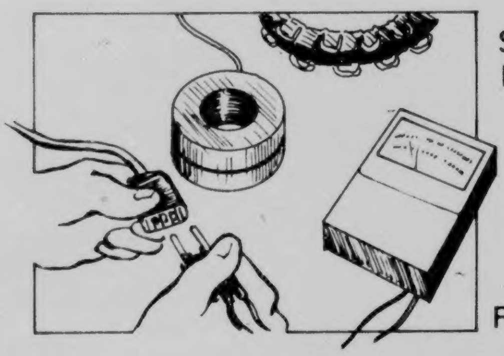
II. Procedure

- A. Bench test field coils for continuity and grounds
  1. To check for continuity, connect the ohmmeter leads to the slip rings of the rotating field coil, or to the two leads of the stationary field coil (Figures 1 and 2)

     (NOTE: A high or infinite resistance indicates a poor connection or a broken wire.)



ROTATING FIELD COIL
FIGURE 1



STATIONARY FIELD COIL

FIGURE 2

## JOB SHEET #2

2. To check for grounds, connect one ohmmeter lead to a slip ring of the rotating field coil or to a lead of the stationary field coil, and the other ohmmeter lead to the metal part of the rotating field coil or metal core of the stationary field coil

   (NOTE: Any continuity indicates a grounded field coil and is defective.)

B. Bench test stator coils for continuity and grounds

1. Connect the ohmmeter leads between any two leads of the stator assembly and test all three leads (Figures 3 and 4)

   (NOTE: No continuity indicates broken wires.)

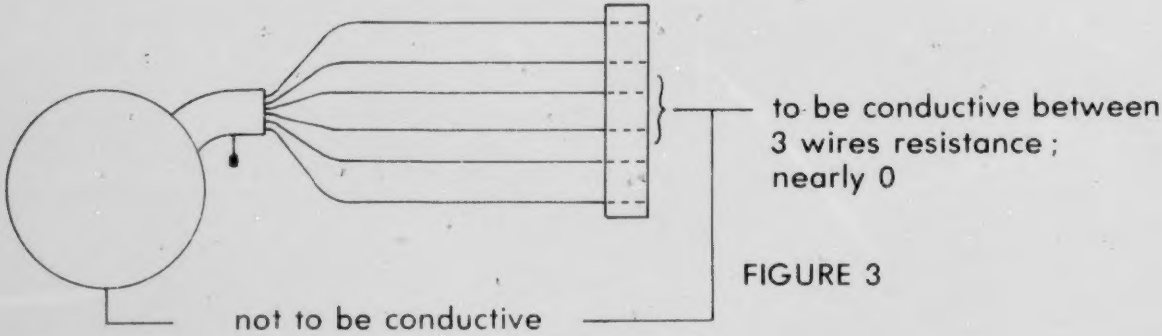


FIGURE 3

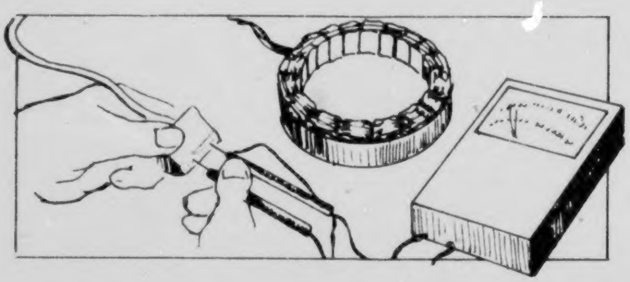


FIGURE 4

2. Connect one ohmmeter lead to a stator coil lead and the other ohmmeter lead to the metal frame (Figure 3)

   (NOTE: Any continuity indicates grounded coils and the stator assembly is defective.)

## JOB SHEET #2

C. Bench test three phase rectifier

1. Using the ohmmeter, test each diode in the rectifier

2. Connect the ohmmeter across each individual diode (Figure 5)

   (NOTE: Consult the appropriate service manual because there are many different makes and models, and color codes vary.)

3. Reverse the connections across the same diode

   (NOTE: The diode should show conductivity in one direction only. Any diode that shows conductivity in both directions, or no conductivity in either direction is defective.)

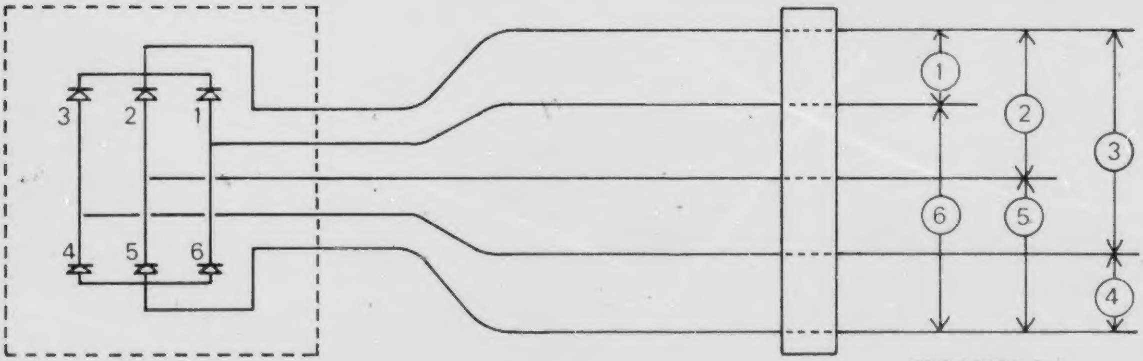


FIGURE 5

## AC ELECTROMAGNETIC THREE PHASE CHARGING SYSTEM
## UNIT II

### JOB SHEET #3--CHECK AND ADJUST VOLTAGE REGULATOR

I. Tools and materials

   A. DC voltmeter

   B. Hand tool assortment

   C. Appropriate service manual

   D. Safety glasses

II. Procedure

   A. Disconnect the rectifier lead from the battery

   B. Connect a DC voltmeter to the rectifier wire and to ground (Figure 1)

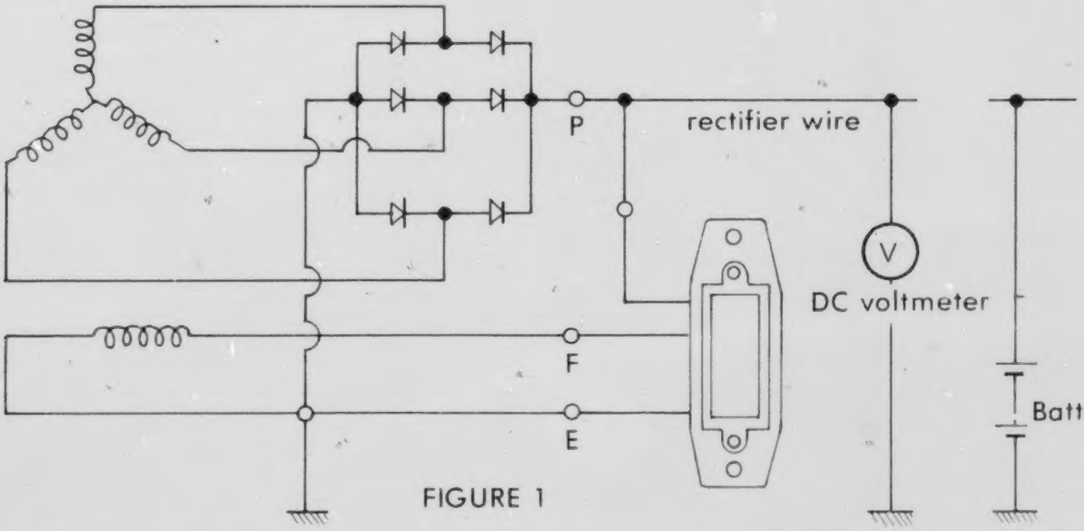


FIGURE 1

   C. Remove the cover from the voltage regulator and locate the adjusting screw or arm

   D. Start the engine and operate at about 4,000 RPM

   E. Test the charging voltage

   (NOTE: On most motorcycles the charging voltage should be between 14 to 15 volts. Consult the service manual for exact specifications.)

JOB SHEET #3

F. To change the voltage, adjust the spring tension on the regulator armature (Figures 2 and 3)

(NOTE: This is usually done with an adjusting screw or arm.)

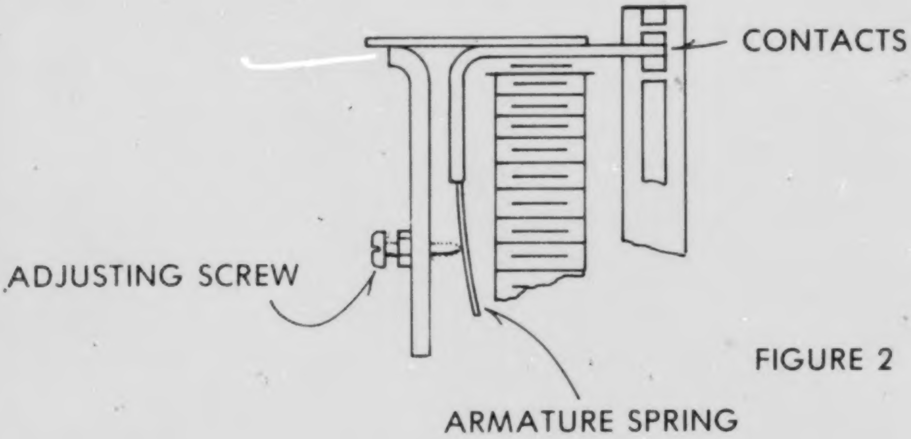

CONTACTS
ADJUSTING SCREW
ARMATURE SPRING

FIGURE 2

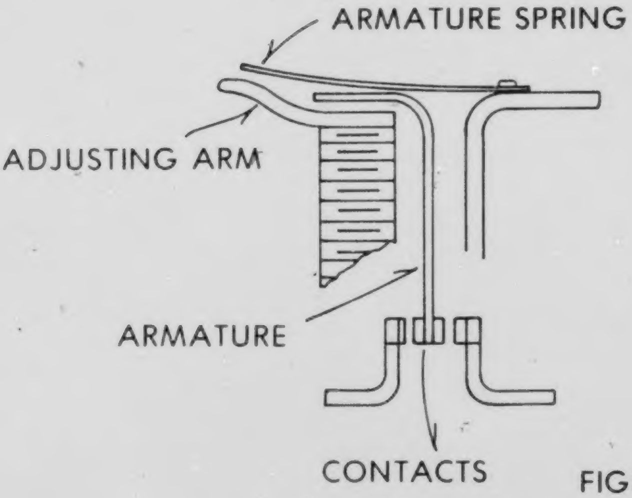

ARMATURE SPRING
ADJUSTING ARM
ARMATURE
CONTACTS

FIGURE 3

G. To increase voltage, increase spring tension; to decrease voltage, decrease spring tension

H. Replace regulator cover and take final voltage reading

M - 79-G

## AC ELECTROMAGNETIC THREE PHASE CHARGING SYSTEM
## UNIT II

NAME ______________________

## TEST

1. Match the terms on the right to the correct definitions.

_____a. Coil of wire through which battery current flows to establish an electromagnetic field for use in the induction process

_____b. Alternator system in which the wave forms are 120° apart per revolution of a single magnetic field

_____c. Brass rings on the rotor shaft which contact the brushes and are used to conduct current into and out of the rotating field coils

_____d. Core of magnetic material surrounded by a coil of wire through which an electrical current is passed to magnetize the core

1. Slip rings
2. Field coil
3. Three phase
4. Electromagnet

2. Select the major components of the AC electromagnetic three phase charging system by placing an "X" in the appropriate blanks.

_____a. Ignition coil

_____b. Voltage regulator

_____c. Battery

_____d. Single coil

_____e. Rotor

_____f. Amplifier

_____g. Stator coils

_____h. Starter

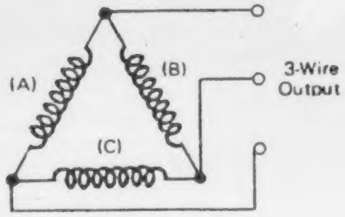
_____i. Alternator housing

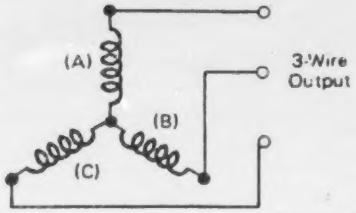
_____j. Field coil

_____k. Points and condenser

_____l. Rectifier (six diode)

3. Identify the types of three phase coil connections.





a. ______________________ b. ______________________

4. Match the types of three phase alternator designs on the right to the correct design characteristics.

______a. Field coil and stator windings both attached to alternator cover

______b. Rotor turns inside of stator assembly

______c. Field coil is wound around the rotor between the pole pieces

______d. Pole pieces of rotor rotate between stator and field coils

______e. Slip rings and brushes used to transmit current to field coil

1. Rotating field coil

2. Stationary field coil

5. Select the circuits used in the AC electromagnetic three phase charging system by placing an "X" in the appropriate blank.

______a. Charging circuit

______b. Open circuit

______c. Field circuit

______d. Lighting circuit

______e. Short circuit

______f. Regulator relay coil circuit

______g. Motocross circuit

6. Describe the operation of the alternator.

7. Describe the operation of the mechanical voltage regulator.

8. Demonstrate the ability to:

   a. Test DC charging rate.

   b. Bench test field coils, stator assembly, and rectifier.

   c. Check and adjust voltage regulator.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

# AC ELECTROMAGNETIC THREE PHASE CHARGING SYSTEM
# UNIT II

## ANSWERS TO TEST

1. a. 2
   b. 3
   c. 1
   d. 4
2. b, c, e, g, i, j, l
3. a. Delta connected
   b. WYE connected
4. a. 2
   b. 1
   c. 1
   d. 2
   e. 1
5. a, c, f
6. Description should include:
   a. Moving magnetic field needed to produce current
      1) Battery voltage passed through field coil to create magnetic field
      2) Magnetic field set into motion when engine is started
      3) AC voltage induced in stator coils
   b. Change to DC
      1) Current is changed from AC to DC as it passes through rectifier
      2) DC charges battery

7. Description should include:

- a. Mode 1
    - 1) Battery voltage low
    - 2) Low current to regulator relay coil
        - a) No magnetic field produced
        - b) Armature pulled up by spring
    - 3) Armature touching upper contact points
    - 4) Alternator field coil current
        - a) Does not pass through resistors
        - b) Amperage is 1.6 amps
    - 5) High field coil current produces strong magnetic field
    - 6) High alternator output
- b. Mode 2
    - 1) Battery voltage normal
    - 2) Higher current to regulator relay coil
        - a) Moderate magnetic field is produced
        - b) Armature now midway between upper and lower contacts
    - 3) Armature not touching either upper or lower contact points
    - 4) Alternator field coil current
        - a) Passes through 10 ohm resistor
        - b) Amperage is 0.7 amps
    - 5) Weak field coil current produces weak magnetic field
    - 6) Lower alternator output

C. Mode 3

1) Battery voltage high

2) High current to regulator relay coil

   a) Strong magnetic field produced

   b) Armature pulled down by magnetic field

3) Armature touching lower contact points

4) Alternator field coil current

   a) Passes through 10 ohm resistor

   b) Through lower contacts to ground

   c) Amperage is 0

5) No field coil current produces no magnetic field

6) No alternator output

8. Performance skills evaluated to the satisfaction of the instructor

# BATTERY IGNITION SYSTEMS
## UNIT III

## UNIT OBJECTIVE

After completion of this unit, the student should be able to identify the components of a battery ignition system and select the types of system designs. He should also be able to match the operating characteristics to the correct type of system designs and demonstrate the ability to adjust ignition timing with a dial indicator and reference marks, and check timing and advance with a timing light. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Identify the components of a battery ignition system.
2. Select the types of battery ignition system designs.
3. Match the types of multi-cylinder ignition system designs to the correct operating characteristics.
4. Demonstrate the ability to:
    a. Adjust ignition timing with dial indicator and ohmmeter.
    b. Adjust ignition timing with reference marks.
    c. Check ignition timing and advance with timing light and tachometer.

# BATTERY IGNITION SYSTEMS
# UNIT III

## SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information sheet.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss the procedures outlined in the job sheets.

   G. From old parts, construct an ignition system mock-up.

   H. Obtain worn or damaged parts for illustration of malfunctions.

   I. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheets.

   D. Complete activities assigned by instructor.

   E. Take test.

## INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Components of Battery Ignition System

      2. TM 2--Basic Battery Ignition System

3. TM 3--Type I Battery Ignition System

4. TM 4--Type II Battery Ignition System

5. TM 5--Type I Variation Battery Ignition System

6. TM 6--Combination Type I and Type II Battery Ignition System

D. Job sheets

1. Job Sheet #1--Adjust Ignition Timing with Dial Indicator and Ohmmeter

2. Job Sheet #2--Adjust Ignition Timing with Reference Marks

3. Job Sheet #3--Check Ignition Timing and Advance with Timing Light and Tachometer

E. Test

F. Answers to test

II. References:

A. *Honda CB750 Service Manual.* Honda Motor Co., Ltd., 1971.

B. *Honda 250-350 Service Manual.* Honda Motor Co., Ltd., 1972.

C. *Honda 450 Service Manual.* Honda Motor Co., Ltd., 1971.

D. *Honda Motorcycle and Power Products Training Manual.* Gardena, California: American Honda Motor Co., 1975.

E. *Motorcycle Electrical Equipment Service Manual.* Publication No. 3621. Joseph Lucas Ltd.

F. *Suzuki T250-T350 Service Manual.* Suzuki Motor Co., Ltd., 1969.

G. *Suzuki GT550 Service Manual.* Suzuki Motor Co., Ltd., 1973.

# BATTERY IGNITION SYSTEMS
## UNIT III

## INFORMATION SHEET

I. Components of a battery ignition system (Transparency 1)

   A. Battery

   B. Fuse

   C. Ignition switch

   (NOTE: Some models also have an emergency kill switch on the handle bars.)

   D. Coil

   E. Contact points

   F. Condenser

   G. Spark plug

   H. Breaker cam

   I. Breaker plate

II. Types of battery ignition system designs

   A. Basic system--Single cylinder engines (Transparency 2)

   B. Type I--Two cylinder engines with 180° crankshaft

   C. Type II--Two cylinder engines with 360° crankshaft

   D. Type I variation--Three cylinder engines

   E. Combination Type I and Type II--Four cylinder engines

III. Operating characteristics of multi-cylinder ignition system designs

   A. Type I (Transparency 3)

      1. Multiple points and condensers (1 for each cylinder)

      2. Multiple coils and condensers (1 for each cylinder)

      3. Fires each plug as needed

## INFORMATION SHEET

B. Type II (Transparency 4)

   1. Single point and condenser
   2. Single coil with dual secondary
   3. Fires both plugs every revolution
      a. One cylinder will be on compression stroke
      b. One cylinder will be on exhaust stroke

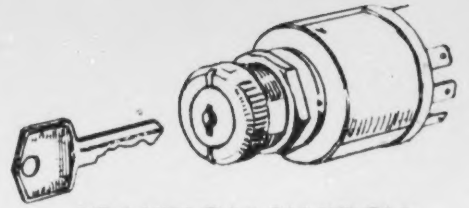
C. Type I variation (Transparency 5)

   1. One set of points and condenser and a coil for each cylinder
   2. Equivalent to three complete Type I ignition systems

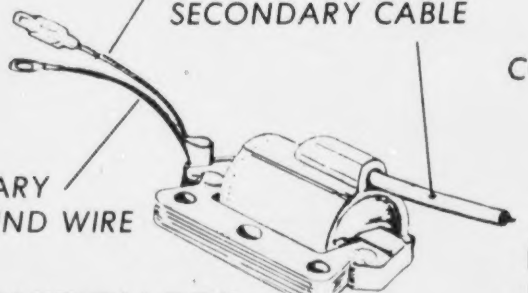
D. Combination Type I and Type II (Transparency 6)

   1. Two points and condensers
   2. Two coils
   3. Fires a combination of two cylinders alternately

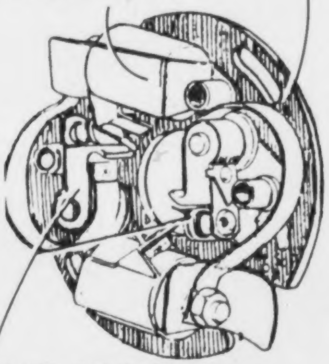
# COMPONENTS OF BATTERY IGNITION SYSTEM

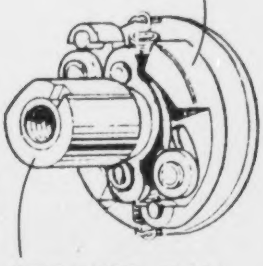


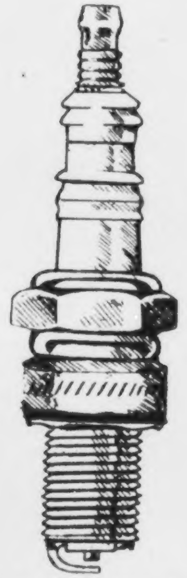
IGNITION SWITCH


PRIMARY WIRE
SECONDARY CABLE
PRIMARY GROUND WIRE

IGNITION COIL

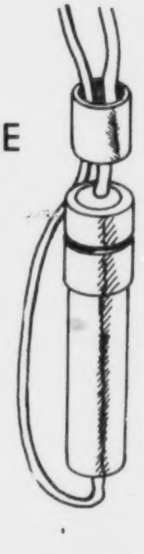

BREAKER PLATE
CONDENSER
CONTACT POINTS

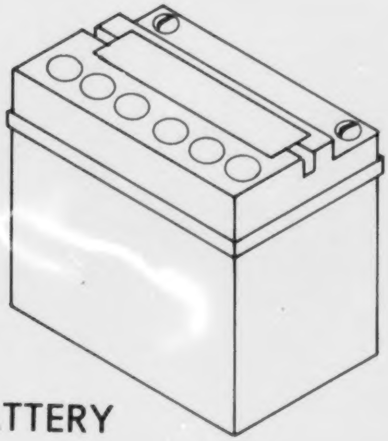

TIMING ADVANCE WEIGHTS
BREAKER CAM



SPARK PLUG

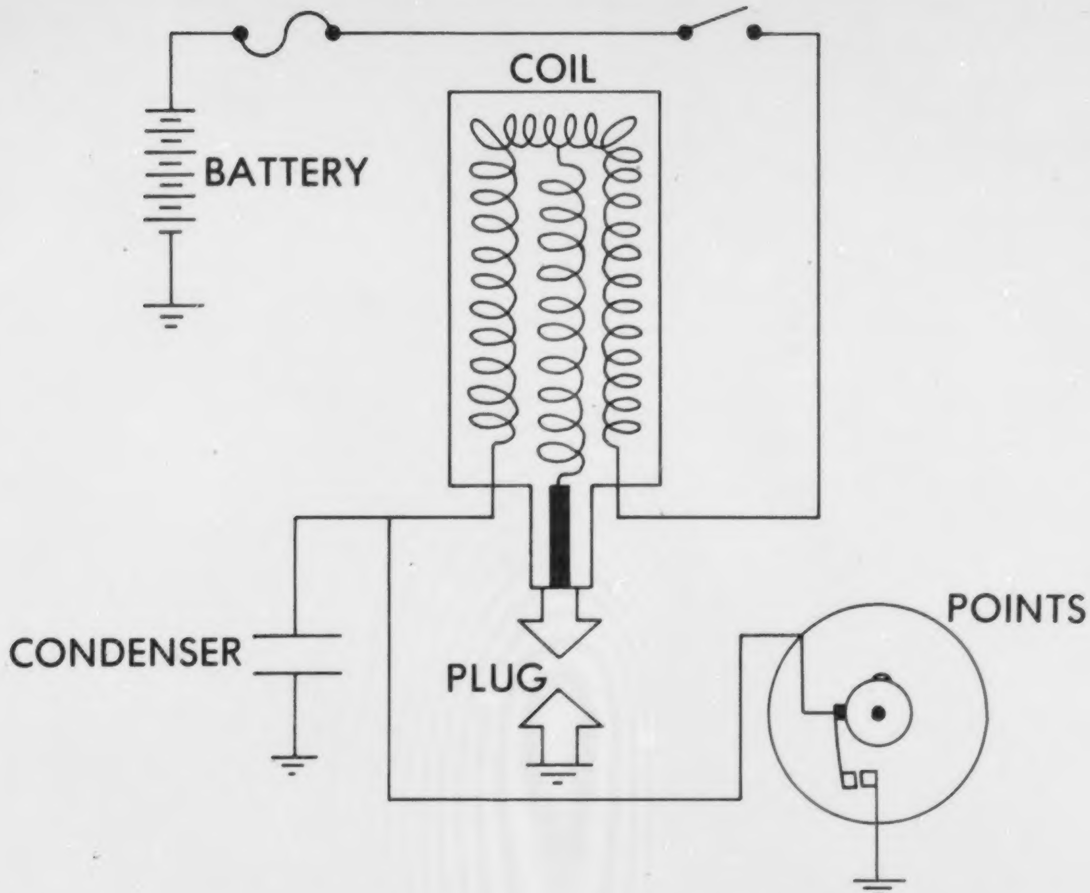
FUSE





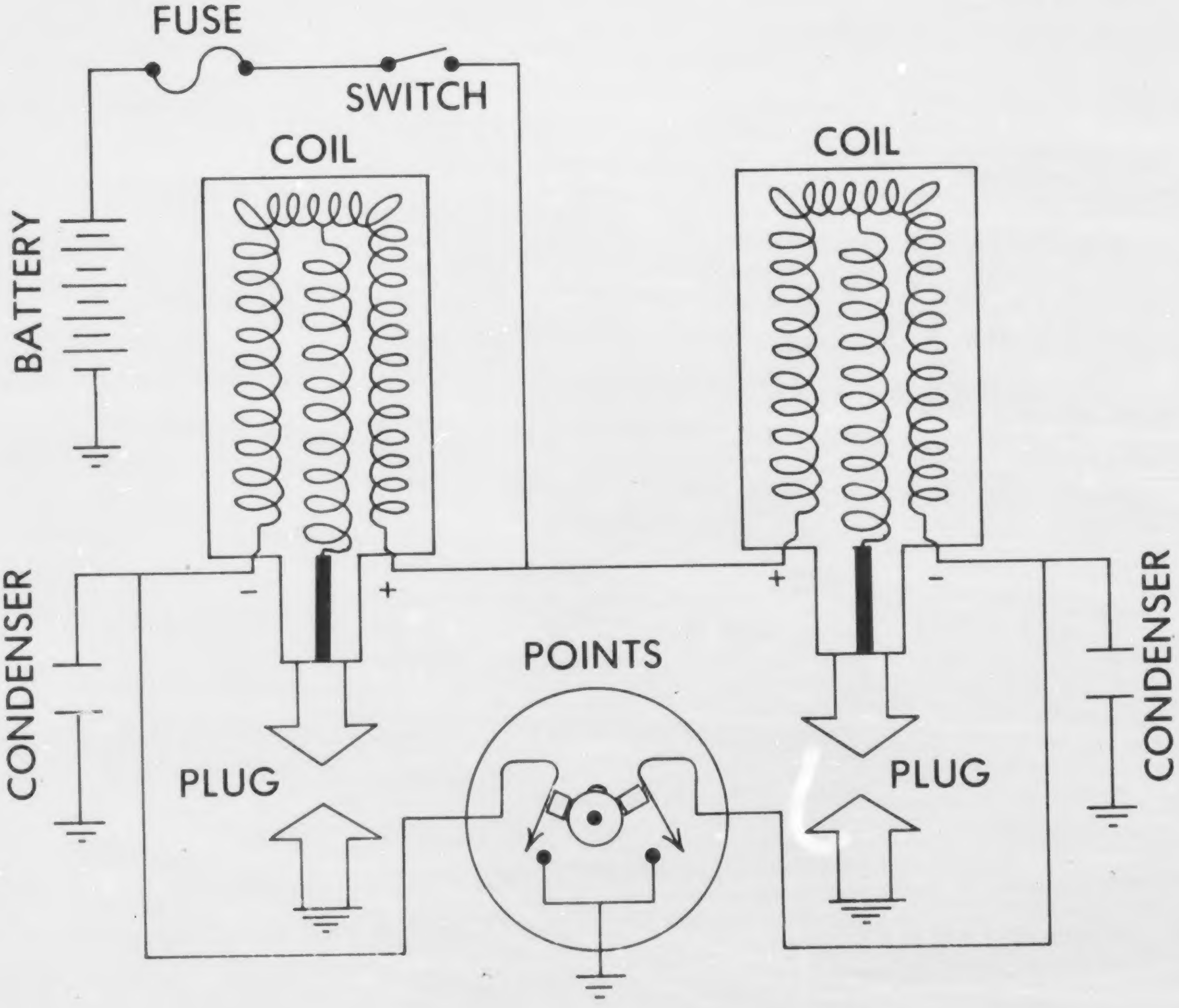
BATTERY

# BASIC BATTERY IGNITION SYSTEM

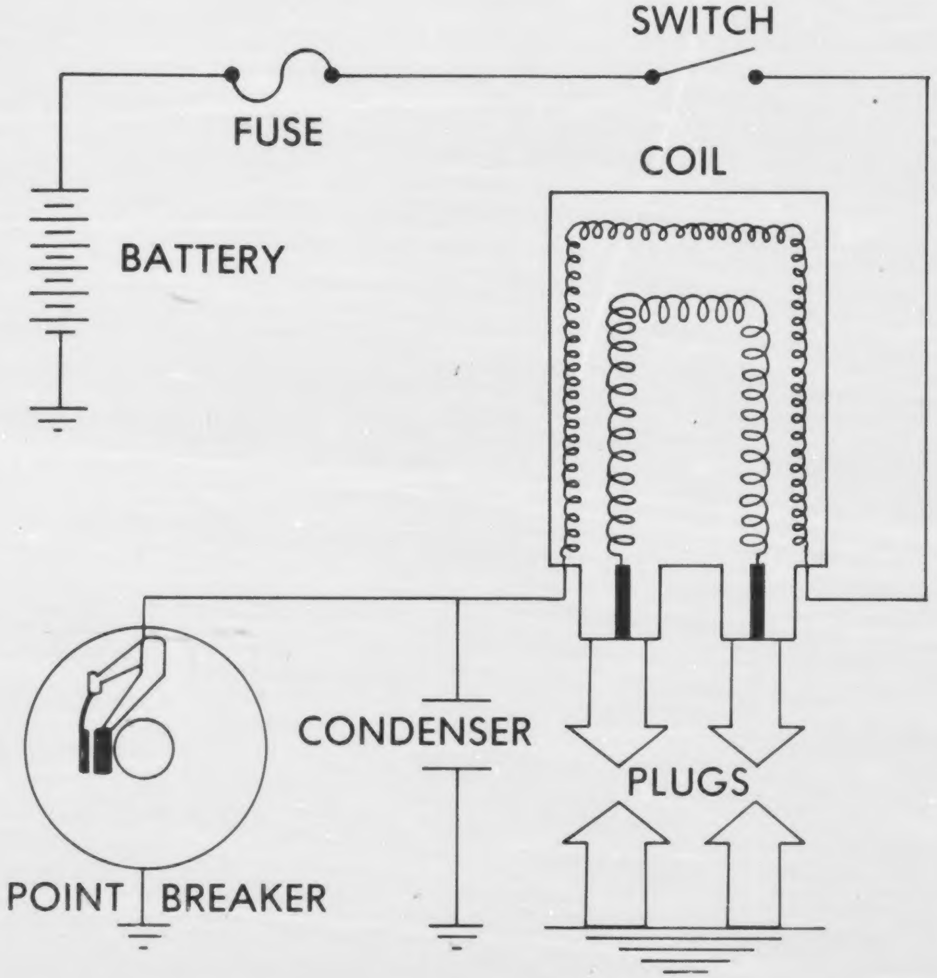

COIL
BATTERY
CONDENSER
PLUG
POINTS

SINGLE CYLINDER DC IGNITION

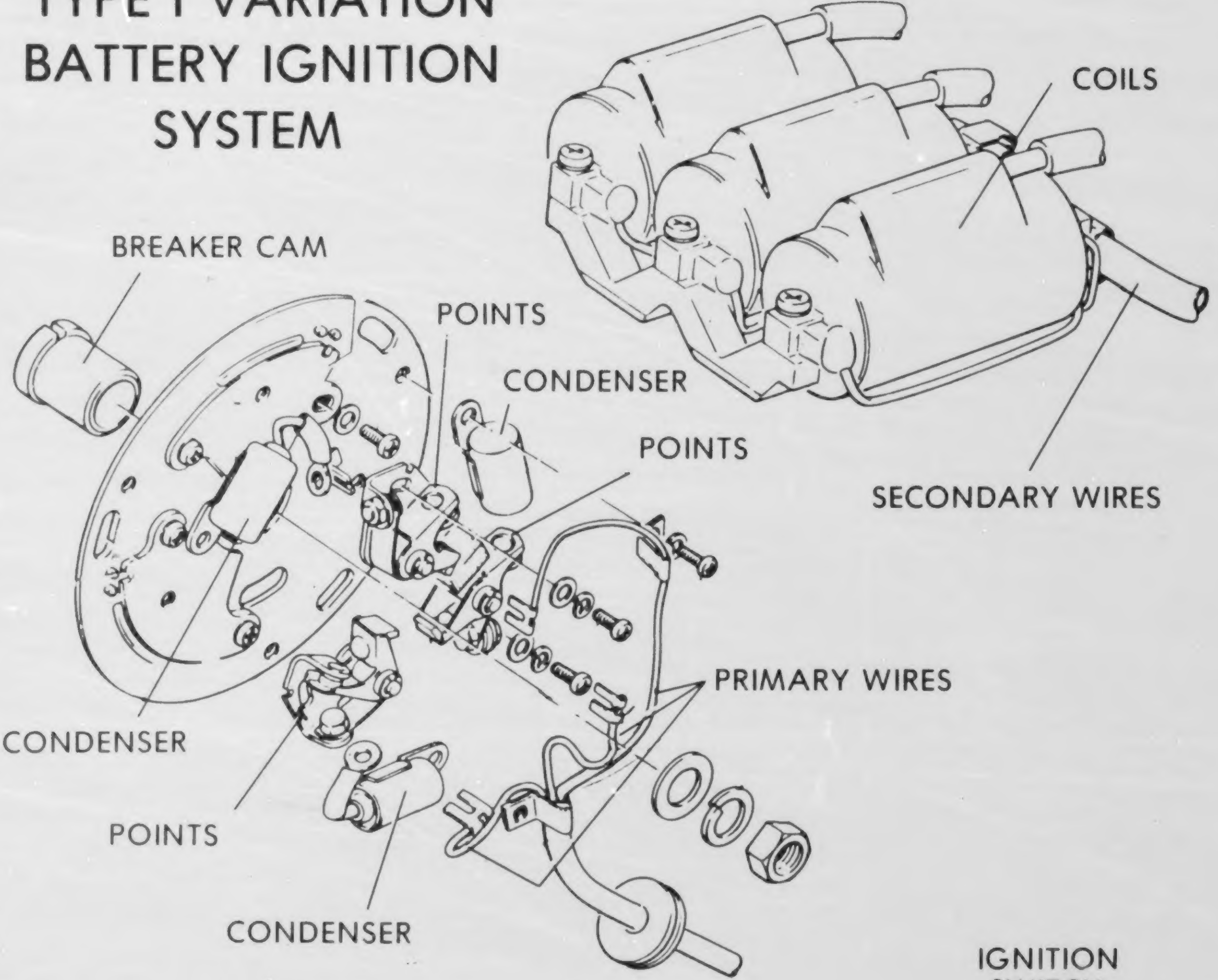
# TYPE I BATTERY IGNITION SYSTEM

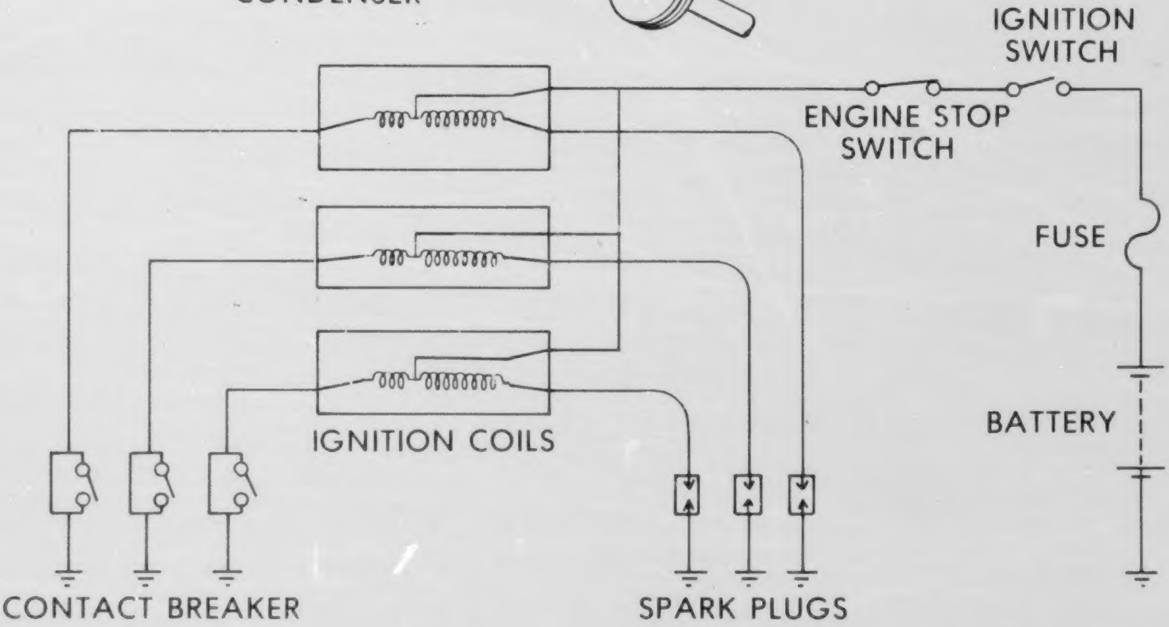

FUSE
SWITCH
COIL
COIL
BATTERY
CONDENSER
CONDENSER
−
+
+
−
POINTS
PLUG
PLUG

# TYPE II BATTERY IGNITION SYSTEM

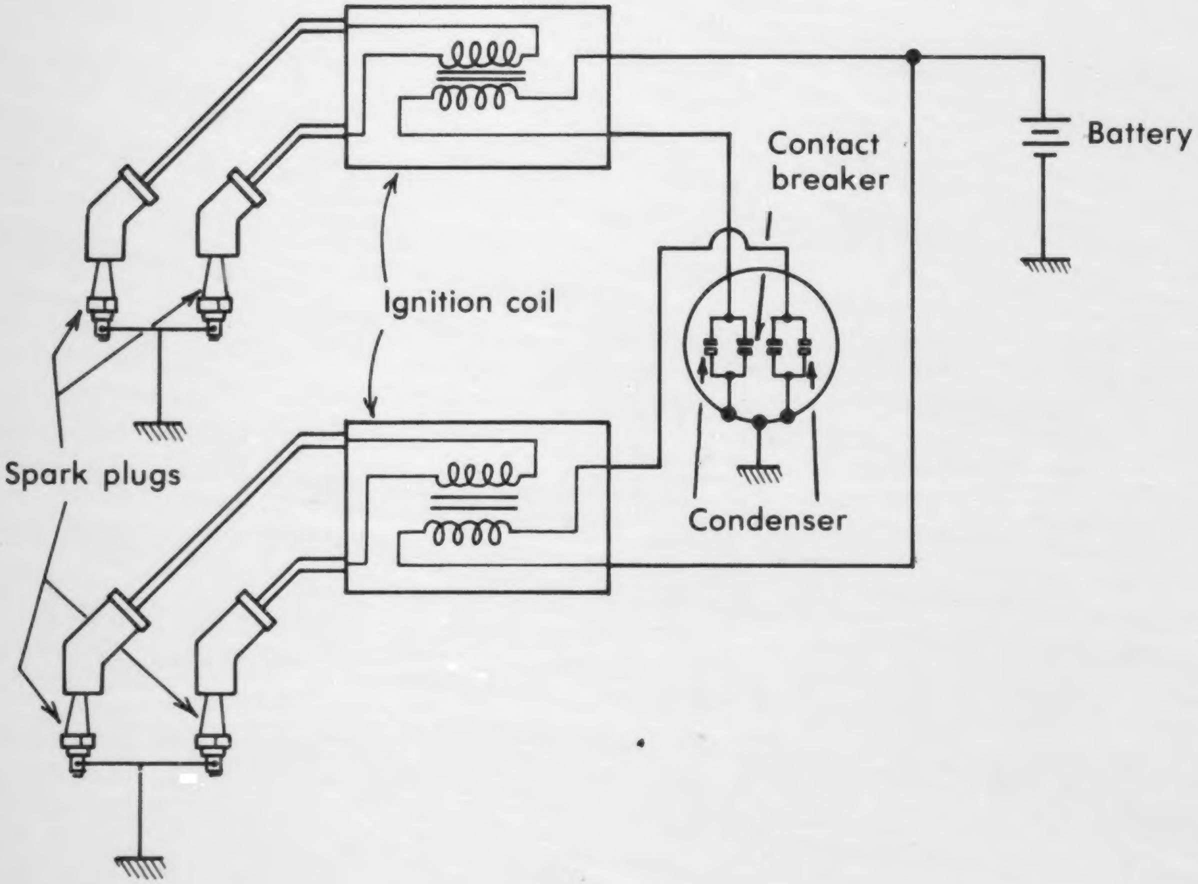

SWITCH
FUSE
COIL
BATTERY
CONDENSER
PLUGS
POINT
BREAKER

# TYPE I VARIATION BATTERY IGNITION SYSTEM


COILS
BREAKER CAM
POINTS
CONDENSER
POINTS
SECONDARY WIRES
PRIMARY WIRES
CONDENSER
POINTS
CONDENSER


IGNITION SWITCH
ENGINE STOP SWITCH
FUSE
BATTERY
IGNITION COILS
CONTACT BREAKER
SPARK PLUGS

# COMBINATION TYPE I AND TYPE II BATTERY IGNITION SYSTEM


Contact breaker
Battery
Ignition coil
Spark plugs
Condenser

# BATTERY IGNITION SYSTEMS
## UNIT III

## JOB SHEET #1--ADJUST IGNITION TIMING WITH DIAL INDICATOR AND OHMMETER

I. Tools and materials

   A. Dial indicator

   B. Spark plug wrench

   C. Ohmmeter or other suitable continuity tester

   D. Ignition point gauge

   E. Hand tool assortment

   F. Appropriate service manual

   G. Safety glasses

II. Procedure

   A. Remove spark plug

   B. Remove contact point cover

   C. Rotate engine until ignition point rubbing block is resting on the highest point of the breaker cam

   D. Adjust the point gap according to service manual specifications for your motorcycle make and model (Figure 1)

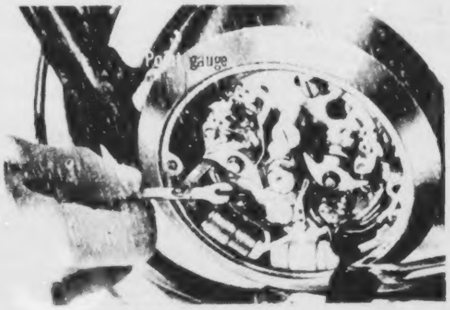


FIGURE 1

   E. Rotate engine until piston is BTDC on compression stroke

   F. Install dial indicator in the spark plug hole

   G. Rotate engine in the direction of normal rotation and locate top dead center

# JOB SHEET #1

H. Zero dial indicator

I. Rotate engine against normal rotation 90°

J. Rotate engine in the direction of normal rotation until piston is the correct distance BTDC as indicated by dial indicator

(CAUTION: Regular dial indicators can be used only on engines with spark plug holes straight through top of cylinder head. Special tools and procedures must be used for engines with angled spark plug holes.)

(NOTE: Most manufacturers specify the distance BTDC in both thousandths of an inch and hundredths of a millimeter.)

K. Disconnect the primary lead or leads from the points

L. Connect the ohmmeter or continuity tester to the primary terminal of the points and to ground (Figure 2)

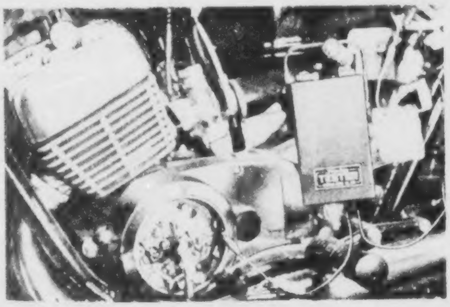


FIGURE 2

M. Loosen the breaker plate mounting screws

N. Rotate the breaker plate as necessary until the exact instant the points open, as indicated by the ohmmeter or other tester

O. Tighten the breaker plate

P. Recheck the timing by turning the engine backwards a short distance and then forward until the dial indicator shows the exact distance BTDC and the points first break

(NOTE: It may be necessary to repeat the procedure until the timing is correct.)

Q. Remove test equipment and reinstall wires, spark plug, and point cover

(NOTE: If the engine is a multi-cylinder with more than one point set, each cylinder must be timed individually. Also, some manufacturers call for the timing to be set with the centrifugal advance, held in its advance position, if so equipped. Consult service manual.)

## BATTERY IGNITION SYSTEMS
## UNIT III

### JOB SHEET #2--ADJUST IGNITION TIMING WITH REFERENCE MARKS

I. Tools and materials

  A. Ohmmeter or continuity tester

  B. Hand tool assortment

  C. Ignition point gauge

  D. Appropriate service manual

  E. Safety glasses

II. Procedure

  A. Adjust timing on individual breaker plates

    1. Remove point cover and flywheel or rotor cover if they are two separate covers

    2. Rotate engine until ignition point rubbing block is resting on the highest point of the breaker cam

    3. Adjust the points according to service manual specifications (Figure 1)

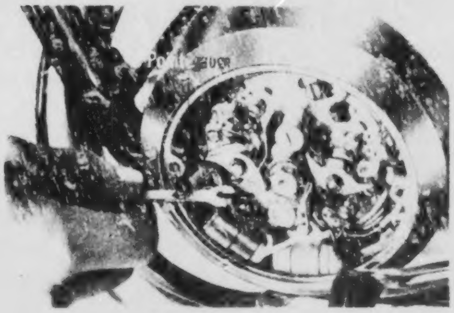


FIGURE 1

(NOTE: Many engines equipped with Type I ignition systems (2 sets of contact points) will have a range that the point gap can be set at, such as .012" to .016" clearance. In this case set the points at .014".)

JOB SHEET #2

4. Rotate the engine until reference marks are in alignment (Figures 2 and 3)

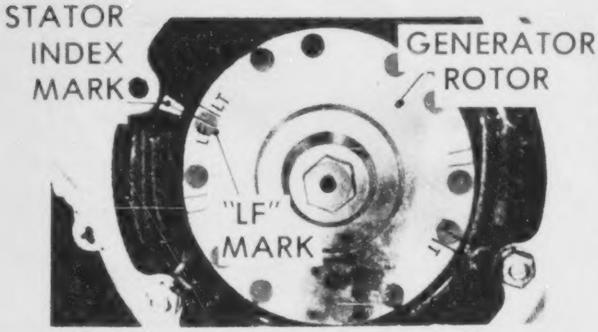


FIGURE 2

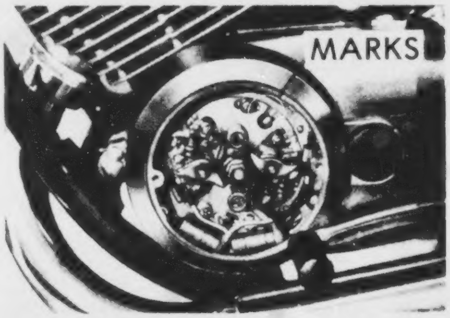


FIGURE 3

(NOTE: Be sure to use the correct reference marks for each cylinder.)

5. Disconnect the primary wires from the points

6. Connect one lead of the continuity tester to the primary terminal and the other lead to ground (Figure 4)

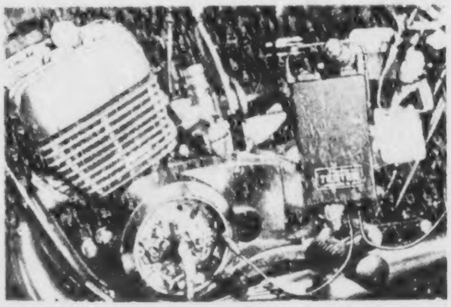


FIGURE 4

7. Loosen and rotate the point breaker plate as necessary, until the exact instant the points open as indicated by the tester

8. Repeat the procedure for each point set on each individual cylinder

## JOB SHEET #2

B. Adjust timing on common breaker plate

1. Time first cylinder by rotating the breaker plate

2. Check second cylinder

   (NOTE: If it needs adjustment, the breaker plate cannot be rotated again as this would change the timing of the first cylinder.)

3. Time second cylinder by regapping the points for that cylinder

   (NOTE: A wider gap will advance the timing, and a closer gap will retard the timing.)

# BATTERY IGNITION SYSTEMS
# UNIT III

## JOB SHEET #3--CHECK IGNITION TIMING AND ADVANCE WITH TIMING LIGHT AND TACHOMETER

I. Tools and materials

A. Timing light

B. Tachometer

C. Ignition point gauge

D. Hand tool assortment

E. Motorcycle equipped with a centrifugal advance and timing reference marks

F. Appropriate service manual

G. Safety glasses

II. Procedure

A. Remove point and/or flywheel or rotor covers

B. Rotate engine until ignition point rubbing block is resting on the highest point of the breaker cam and adjust point gap to correct specifications

C. Connect the timing light to the battery, plug cable, and plug

(NOTE: If a multi-cylinder engine is to be checked, each cylinder must be checked individually.)

D. Connect the tachometer to the system

E. Start the engine and let it idle

## JOB SHEET #3

F. Point the flashing timing light at the reference marks (Figure 1)

(NOTE: If timed correctly, the reference marks will be in alignment each time the light flashes. If reference marks do not line up, the breaker plate must be rotated or the point gap readjusted.)

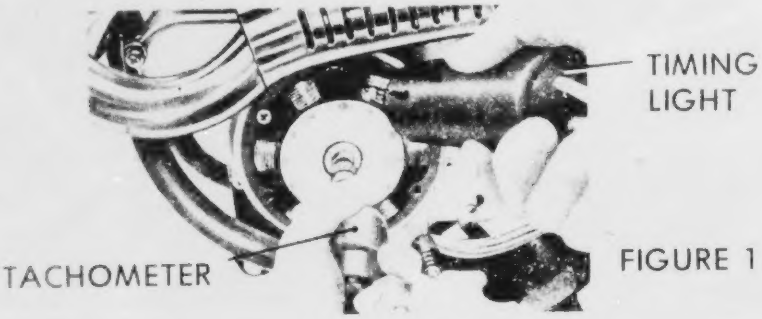


FIGURE 1

G. Consult the service manual for the degrees of advance and RPM specifications

H. Speed engine up to specified RPM and check the amount of spark advance on the reference marks

(NOTE: If advance is incorrect, inspect the centrifugal advance mechanism for binding of the weights or breaker cam, weak or broken springs, and worn pivot pins.)

I. Remove the timing light and tachometer and replace all covers

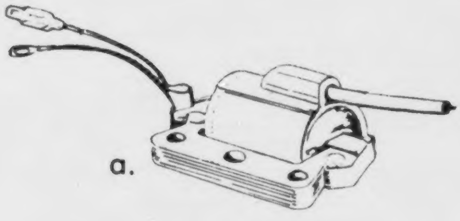
# BATTERY IGNITION SYSTEMS
# UNIT III

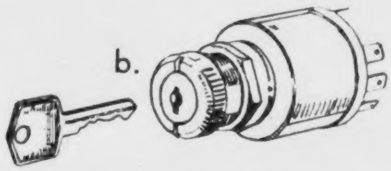
NAME ______________________

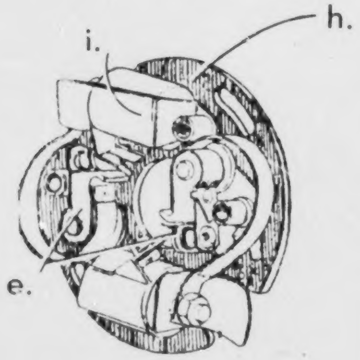
## TEST

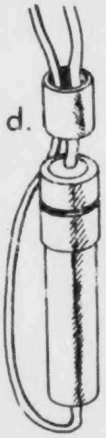
1. Identify the components of a battery ignition system.

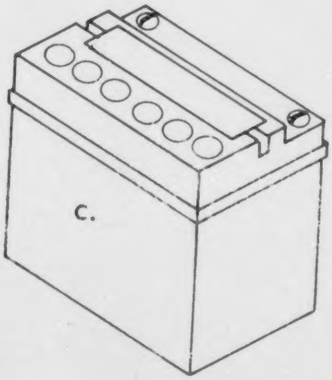
a. ______________
b. ______________
c. ______________
d. ______________
e. ______________
f. ______________
g. ______________
h. ______________
i. ______________

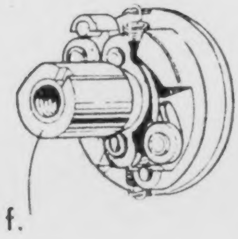


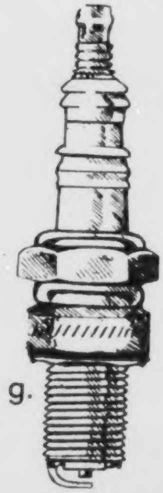












2. Select the types of battery ignition system designs by placing an "X" in the appropriate blanks.

______a. Combination Type I and Type II

______b. Combination Type II and Type IV

______c. Type I

______d. Basic system

______e. Type II variation

______f. Type I variation

______g. Type IV

______h. Type II

3. Match the types of multi-cylinder ignition system designs on the right to the correct operating characteristics.

______a. Fires a combination of two cylinders alternately

______b. Fires both plugs every revolution

______c. One set of points and condenser and a coil for each cylinder

______d. Fires each plug as needed

1. Type I variation
2. Type I
3. Combination Type I and Type II
4. Type II

4. Demonstrate the ability to:

a. Adjust ignition timing with dial indicator and ohmmeter.

b. Adjust ignition timing with reference marks.

c. Check ignition timing and advance with timing light and tachometer.

(NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

# BATTERY IGNITION SYSTEMS
## UNIT III

## ANSWERS TO TEST

1. a. Coil
   b. Ignition switch
   c. Battery
   d. Fuse
   e. Contact points
   f. Breaker cam
   g. Spark plug
   h. Breaker plate
   i. Condenser
2. a, c, d, f, h
3. a. 3
   b. 4
   c. 1
   d. 2
4. Performance skills evaluated to the satisfaction of the instructor

# ENERGY TRANSFER IGNITION SYSTEMS
## UNIT IV

## UNIT OBJECTIVE

After completion of this unit, the student should be able to identify the components of the energy transfer ignition system, describe the operation of this system, and distinguish between the energy transfer system and the conventional magneto system. The student should also demonstrate the ability to test the energy transfer ignition system. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Identify the components of the energy transfer ignition system.
2. Describe the operation of the energy transfer ignition system.
3. Distinguish between the energy transfer ignition system and the conventional magneto ignition system.
4. Demonstrate the ability to test energy transfer system for continuity and grounds.

# ENERGY TRANSFER IGNITION SYSTEMS
## UNIT IV

## SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss the procedure outlined in the job sheet.

  G. Construct a mock-up of an energy transfer system from available used parts.

  H. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Complete job sheet.

  D. Complete activities assigned by instructor.

  E. Take test.

## INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Components of Energy Transfer Ignition System

    2. TM 2--Operation of Energy Transfer Ignition System

D. Job Sheet #1--Test Energy Transfer System for Continuity and Grounds

E. Test

F. Answers to test

II. References:

A. *Honda Motorcycle and Power Products Training Manual.* Gardena, California: American Honda Motor Co., 1975.

B. *U.S. Suzuki Technical Training Centers Training Handouts.* U.S. Suzuki Motor Co., Ltd., 1975.

C. *Suzuki Constructions and Works of Electrical Equipment.* Suzuki Motor Co., Ltd.

D. *Motorcycle Service Manual.* Vol. 1. 3rd ed. Kansas City, Missouri: Technical Publications Division/Intertec Publishing Corp., 1972.

E. *Chilton's New Motorcycle Troubleshooting Guide.* Radnor, Pennsylvania: Chilton Book Co., 1973.

# ENERGY TRANSFER IGNITION SYSTEMS
## UNIT IV

## INFORMATION SHEET

I. Components of the energy transfer ignition system (Transparency 1)

   A. Magnetic flywheel

   B. Primary coil

      (NOTE: This is sometimes called the energy transfer coil.)

   C. Contact points

   D. Condenser

   E. Ground type ignition switch

   F. Secondary ignition coil and secondary wire

   G. Spark plug

   H. Breaker cam

   (NOTE: The magnetic flywheel and primary coil are used in place of the battery to generate electrical power.)

II. Operation of energy transfer ignition system (Transparency 2)

   A. Ignition switched on

      1. Ground circuit opens

      2. Allows current to flow from primary coil to ignition coil

         (NOTE: No current actually flows until engine is cranked.)

   B. Engine cranked

      1. Magnetic flywheel induces current in primary coil

         a. With ignition points closed, induced current flows in a loop back to ground

         b. With ignition points open, induced current flows to ignition coil

      2. Timing and advance controlled by flywheel speed

# INFORMATION SHEET

C. Ignition switched off

1. Ground circuit closes
2. No current flow from primary coil to ignition coil

III. Differences between energy transfer ignition and conventional magneto ignition systems

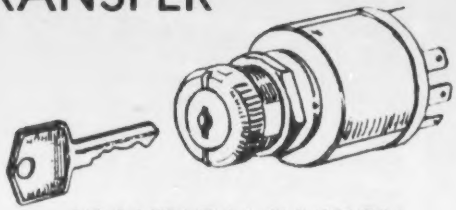
A. Energy transfer system

1. Magnetic flywheel induces current in primary coil
2. Primary coil powers ignition coil primary winding
3. Primary winding of ignition coil induces current into secondary coil to fire the plug

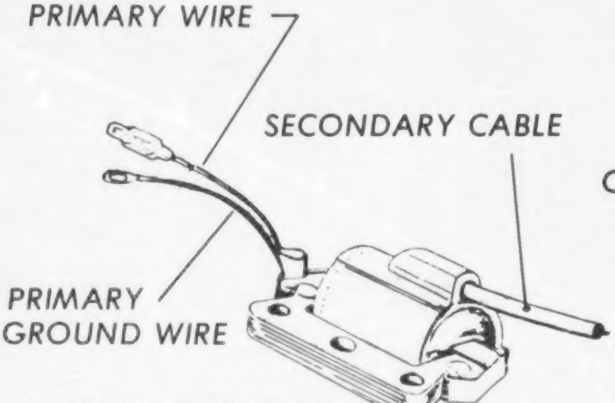
B. Conventional magneto system

1. Magnetic flywheel induces current in primary coil
2. Primary coil is also primary winding in ignition coil
3. Secondary winding fires the plug

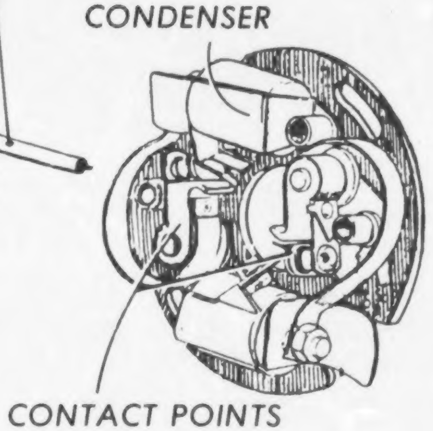
# COMPONENTS OF ENERGY TRANSFER IGNITION SYSTEM

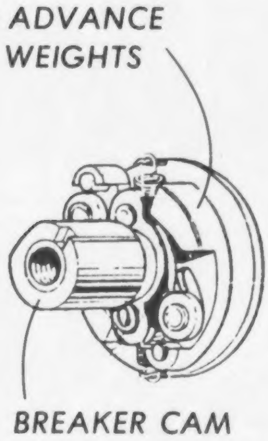


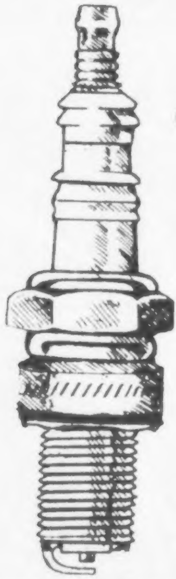
IGNITION SWITCH


PRIMARY WIRE
SECONDARY CABLE
PRIMARY
GROUND WIRE

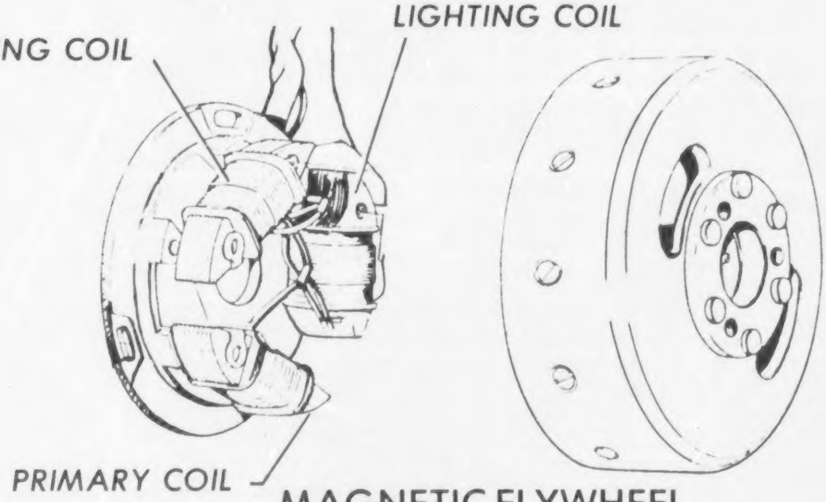
IGNITION COIL


CONDENSER
CONTACT POINTS


TIMING ADVANCE
WEIGHTS
BREAKER CAM

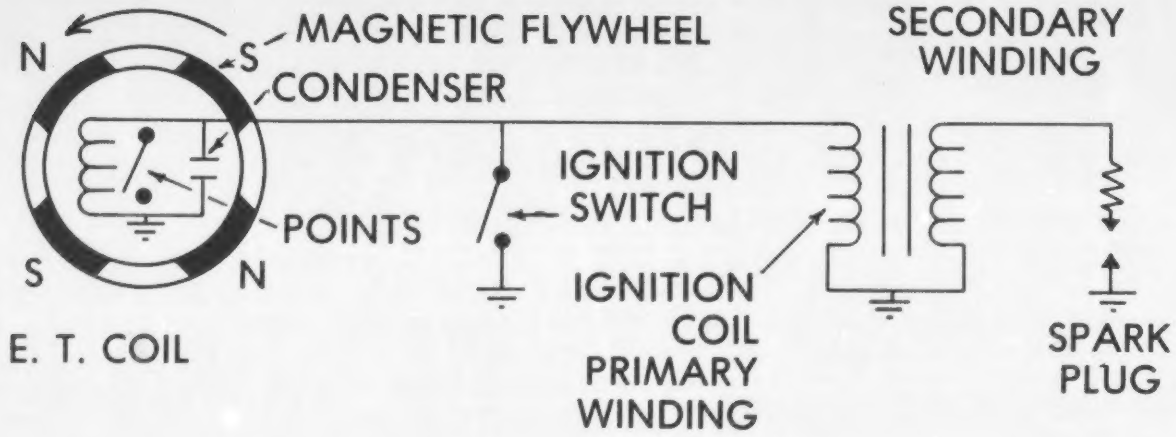


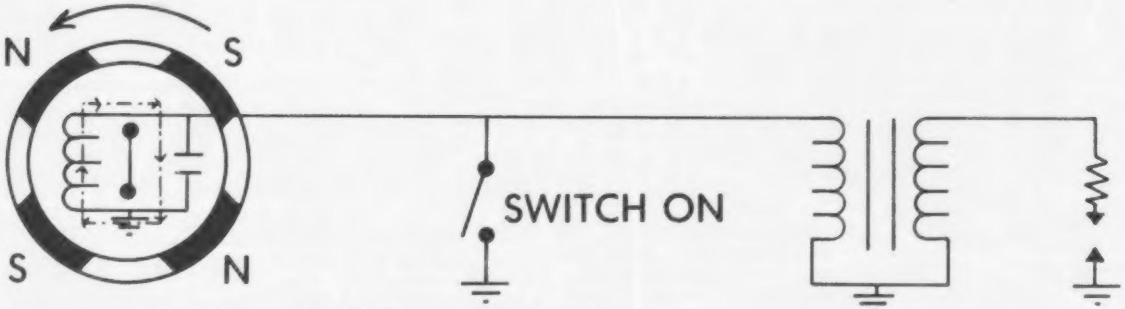
SPARK PLUG


CHARGING COIL
LIGHTING COIL
PRIMARY COIL

MAGNETIC FLYWHEEL

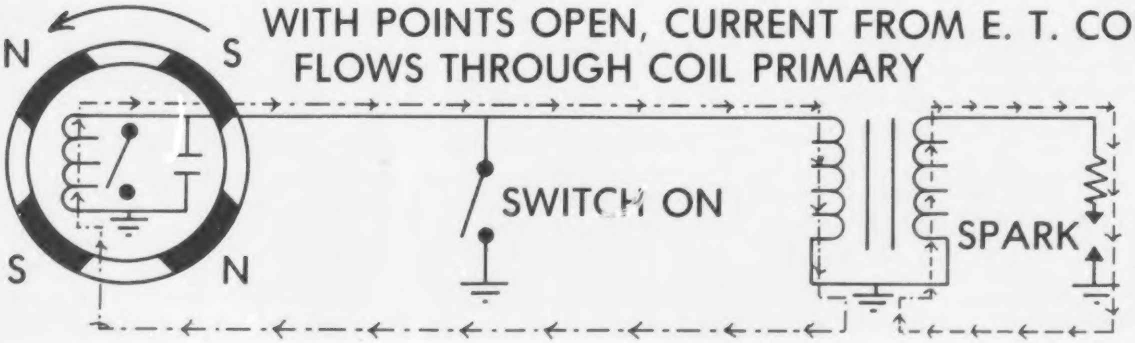
# OPERATION OF ENERGY TRANSFER IGNITION SYSTEM


N
S
MAGNETIC FLYWHEEL
CONDENSER
SECONDARY WINDING
IGNITION SWITCH
POINTS
S
N
IGNITION COIL PRIMARY WINDING
SPARK PLUG
E. T. COIL


N
S
SWITCH ON
S
N

WITH POINTS CLOSED CURRENT FROM E. T. COIL FLOW IN A LOOP

WITH POINTS OPEN, CURRENT FROM E. T. COIL FLOWS THROUGH COIL PRIMARY


N
S
SWITCH ON
SPARK
S
N

# ENERGY TRANSFER IGNITION SYSTEMS
## UNIT IV

## JOB SHEET #1--TEST ENERGY TRANSFER SYSTEM FOR CONTINUITY AND GROUNDS

I. Tools and materials

A. Motorcycle equipped with energy transfer ignition system

B. Appropriate flywheel puller

C. Ohmmeter

D. Hand tool assortment

E. Appropriate service manual

F. Safety glasses

II. Procedure

A. Remove the flywheel cover

B. Remove flywheel retaining nut on crankshaft

C. Remove the flywheel by pulling the flywheel with the prescribed puller

D. Disconnect the primary coil lead from the points

E. Connect the ohmmeter to the disconnected primary coil lead and to ground

(NOTE: The ohmmeter should give a very low reading.)

F. Disconnect the ground lead of the primary coil and repeat the above test

(NOTE: The ohmmeter should now show infinity. Any low reading at all indicates the primary coil is grounded internally.)

G. Connect the ohmmeter across each lead of the primary coil

(NOTE: The reading should be very low, indicating no breaks in the coil wire.)

H. Test the ignition switch by connecting an ohmmeter lead to the switch terminal that connects to the primary coil and the other ohmmeter lead to ground

(NOTE: With the switch turned off, there should be a very low reading; with the switch turned on, the reading should be infinity. To avoid a false reading be sure the primary wire of the ignition coil is disconnected during the switch test.)

## JOB SHEET #1

I. Connect the ohmmeter to the ignition coil primary lead and to ground

(NOTE: With the ground lead of the coil primary connected, the ohmmeter should give a very low reading.)

J. Take reading with the ground lead disconnected

(NOTE: The ohmmeter reading should be infinity.)

K. Connect the ohmmeter across the two primary leads of the ignition coil

(NOTE: The reading should be very low indicating an unbroken primary winding.)

# ENERGY TRANSFER IGNITION SYSTEMS
## UNIT IV

NAME ______________________________

## TEST

1. Identify the components of the energy transfer ignition system.

   a.

   b.

   c.

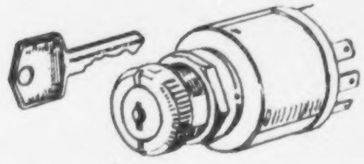
   d.

   e.

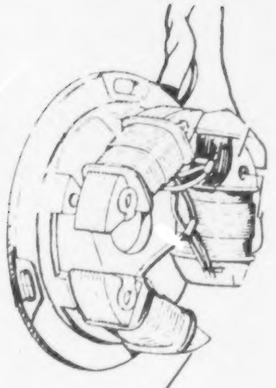
   f.

   g.

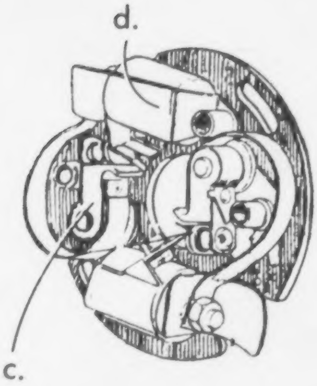
   h.

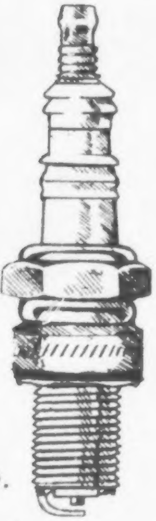


b.

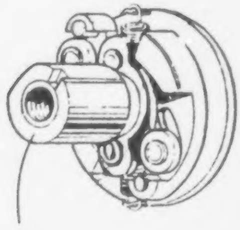


a.

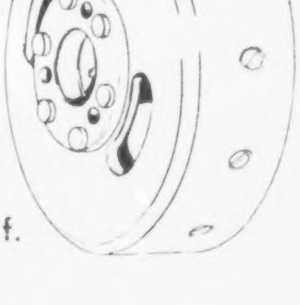




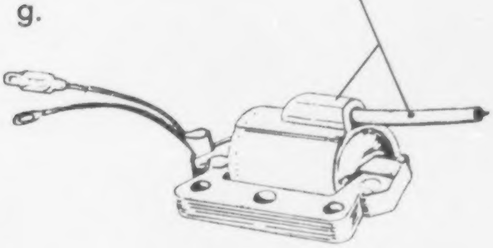
e.



g.



f.



h.

2. Describe the operation of the energy transfer ignition system.

3. Distinguish between the energy transfer ignition system and the conventional magneto ignition system by placing an "X" next to the description of the conventional magneto system.

   _____a. Primary coil is also primary winding in ignition coil

   _____b. Primary coil powers ignition coil primary winding

4. Demonstrate the ability to test energy transfer system for continuity and grounds.

   (NOTE: If this activity has not been accomplished prior to the test, ask your instructor when it should be completed.)

# ENERGY TRANSFER IGNITION SYSTEMS
## UNIT IV

## ANSWERS TO TEST

1. a. Primary coil
   b. Ground type ignition switch
   c. Contact points
   d. Condenser
   e. Spark plug
   f. Magnetic flywheel
   g. Breaker cam
   h. Secondary ignition coil and secondary wire
2. Description should include:
   a. Ignition switched on
      1) Ground circuit opens
      2) Allows current to flow from primary coil to ignition coil
   b. Engine cranked
      1) Magnetic flywheel induces current in primary coil
         a) With ignition points closed, induced current flows in a loop back to ground
         b) With ignition points open, induced current flows to ignition coil
      2) Timing and advance controlled by flywheel speed
   c. Ignition switched off
      1) Ground circuit closes
      2) No current flow from primary coil to ignition coil
3. a
4. Performance skill evaluated to the satisfaction of the instructor

# CAPACITOR DISCHARGE IGNITION SYSTEMS
# UNIT V

## UNIT OBJECTIVE

After completion of this unit, the student should be able to match the terms associated with the CDI system to the definitions and symbols. The student should also be able to identify the major components and arrange in order the steps in the operation of this system. The student should also demonstrate the ability to test exciter, signal, and ignition coils. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with CDI systems to the correct definitions.
2. Match terms associated with CDI systems to the correct symbols.
3. Discuss the advantages of the CDI system.
4. Identify the major components of the CDI system.
5. Arrange in order the steps in the operation of the CDI system.
6. Demonstrate the ability to:
    a. Test exciter and signal coils.
    b. Test ignition coil.

# CAPACITOR DISCHARGE IGNITION SYSTEMS
## UNIT V

## SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information sheet.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss the procedures outlined in the job sheets.

   G. Demonstrate operation of diodes and resistors by use of test equipment.

   H. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheet.

   D. Complete activities assigned by the instructor.

   E. Take test.

## INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1-Symbols

      2. TM 2-Major Components of the CDI System

      3. TM 3-Operation of the CDI System

D. Job sheets

1. Job Sheet #1--Test Exciter and Signal Coils

2. Job Sheet #2--Test Ignition Coil

E. Test

F. Answers to test

II. References:

A. *Honda Motorcycle and Power Product Training Manual.* Gardena, California: American Honda Motor Co., Inc., 1975.

B. *U.S. Suzuki Technical Training Center Training Handouts.* Suzuki Motor Co., Ltd., 1975.

C. *Suzuki Construction and Works of Electrical Equipment.* Suzuki Motor Co., Ltd.

D. *Chilton's New Motorcycle Troubleshooting Guide.* Radnor, Pennsylvania: Chilton Book Co., 1973.

# CAPACITOR DISCHARGE IGNITION SYSTEMS
## UNIT V

## INFORMATION SHEET

I. Terms and definitions

A. CDI--Capacitor discharge ignition

B. Semiconductor--Any of a class of solids whose conductivity is between that of a conductor and that of an insulator

C. Solid state--Circuits and components using semiconductors

D. Capacitor--Device consisting of two conducting surfaces separated by an insulating material that will absorb and hold a charge of electricity until discharged

E. Transistor--Semiconductive device which conducts when a specific current is applied and does not conduct when the specific current is removed

F. Thyristor--Type of electronic switching device similar to transistors and SCRs

G. Exciter coil--Special generating coil in the alternator that provides the capacitor with charging voltage

H. Signal coil--Special generating coil in the alternator that provides the signal voltage to activate the SCR or thyristor

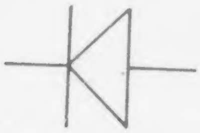
(NOTE: Signal coils are also referred to as pulsar coils and timing detectors.)

I. Trigger circuit--Circuit that triggers the SCR or thyristor and allows the capacitor to discharge

(NOTE: This circuit controls ignition timing.)

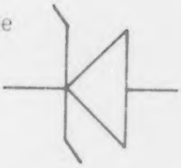
II. Terms and symbols (Transparency 1)

A. Diode

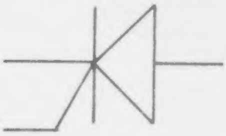


## INFORMATION SHEET

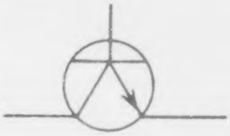
B. Zener diode



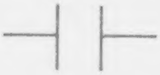
C. Silicon controlled rectifier (SCR)



D. Transistor



E. Capacitor



III. Advantages of the CDI system

A. No moving parts in contact

1. No wear
2. Reduced maintenance
3. Greater durability
4. Accurate and consistant timing

B. Higher voltage to the spark plug

1. Eliminates plug fouling
2. Improves high RPM performance

IV. Major components of the CDI system (Transparency 2)

A. Magnetic flywheel

B. Exciter coil

## INFORMATION SHEET

C. Signal coil

D. Control unit

(NOTE: The control unit includes diodes, zener diodes, SCR, capacitor, and various resistors.)

E. Ignition coil and secondary cable

(NOTE: This includes the primary winding and secondary winding as in the conventional ignition system.)

F. Ignition switch

G. Spark plug

V. Operation of the CDI system (Transparency 3)

A. Magnetic flywheel generates alternating current in exciter coil

B. Current is rectified by one or more diodes

C. Rectified current charges large capacitor to approximately 300 V

D. Alternating current also generated in signal coil

E. Current charges small capacitor in trigger circuit

(NOTE: Exciter coil and signal coil are both housed in the alternator.)

F. Predetermined high voltage in signal coil opens a circuit through zener diode and sends voltage to small SCR

G. SCR triggers small capacitor to discharge and activate gate on large SCR

H. Large SCR triggers large capacitor

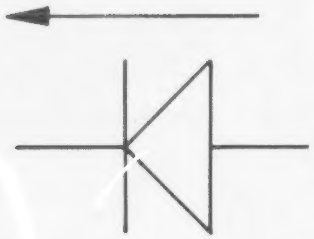
I. High voltage from large capacitor discharged through primary windings of ignition coil

J. High voltage from capacitor builds very strong and rapid magnetic field

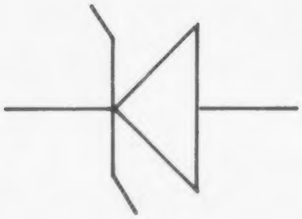
K. Strong primary voltage induces strong secondary voltage

L. Very high voltage spark produced at spark plug

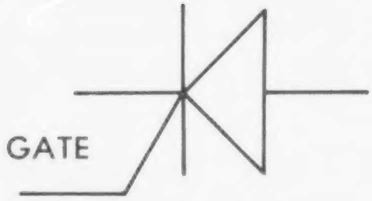
# SYMBOLS



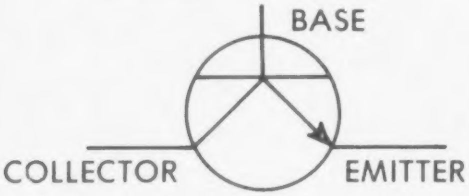
Diode



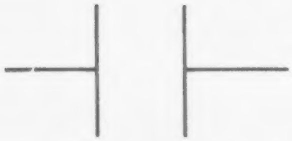
Zener Diode



Silicon Controlled Rectifier (SCR)

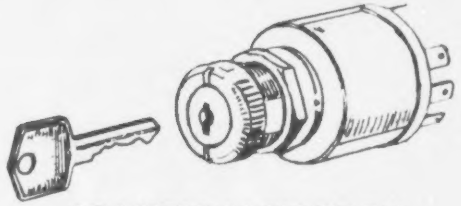

BASE
COLLECTOR
EMITTER

Transistor

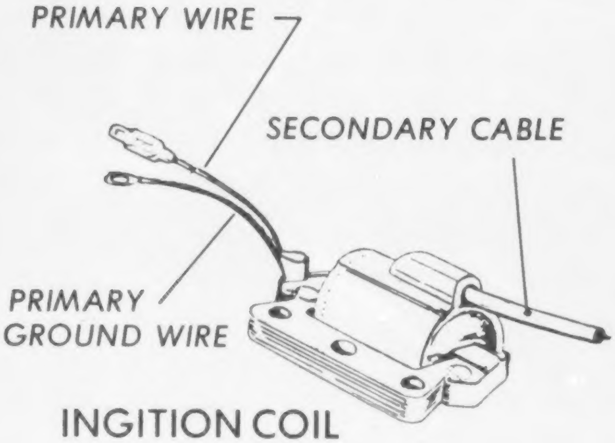


Capacitor

# MAJOR COMPONENTS OF THE *CDI* SYSTEM

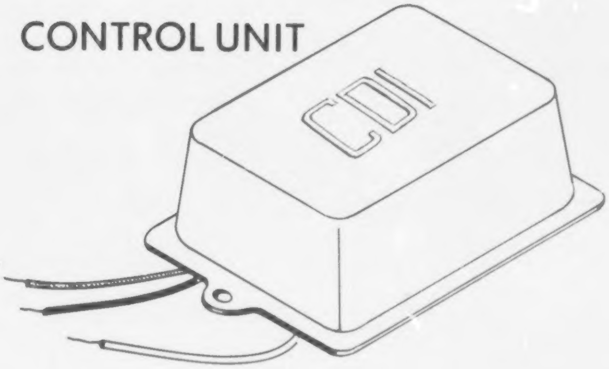


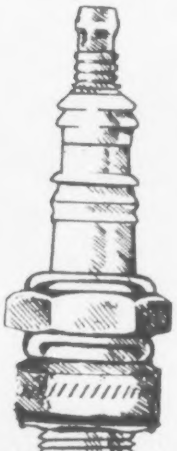
IGNITION SWITCH


PRIMARY WIRE
SECONDARY CABLE
PRIMARY GROUND WIRE

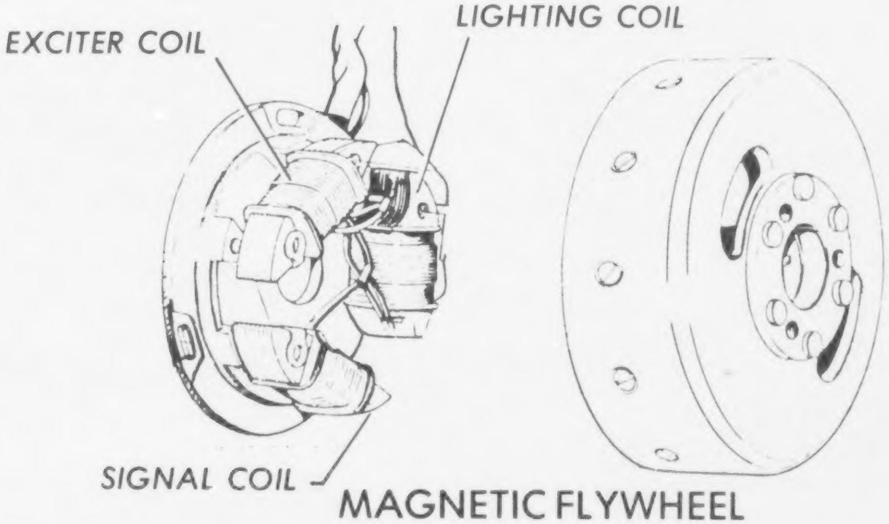
INGITION COIL

CONTROL UNIT





SPARK PLUG


EXCITER COIL
LIGHTING COIL
SIGNAL COIL

MAGNETIC FLYWHEEL

# OPERATION OF THE CDI SYSTEM

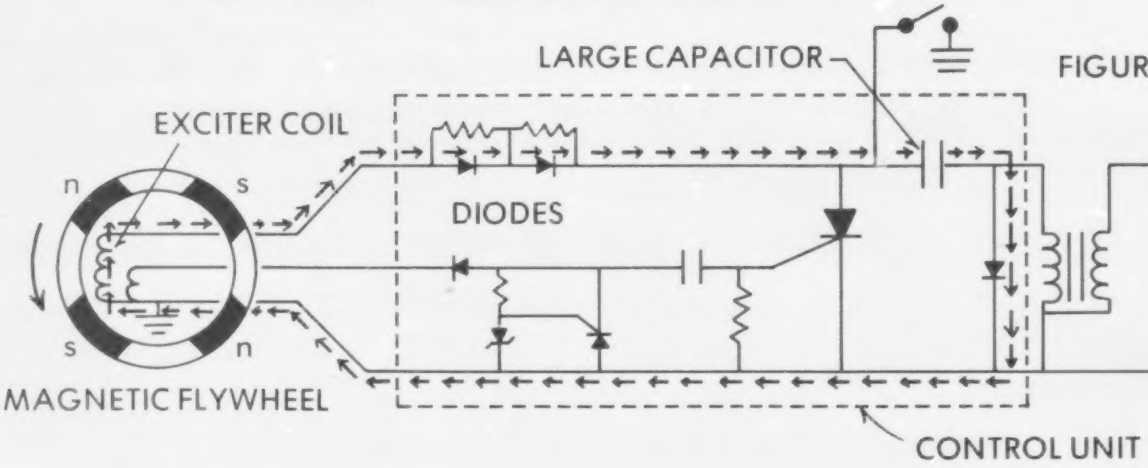

LARGE CAPACITOR
EXCITER COIL
n
s
DIODES
s
n
MAGNETIC FLYWHEEL
CONTROL UNIT

FIGURE 1

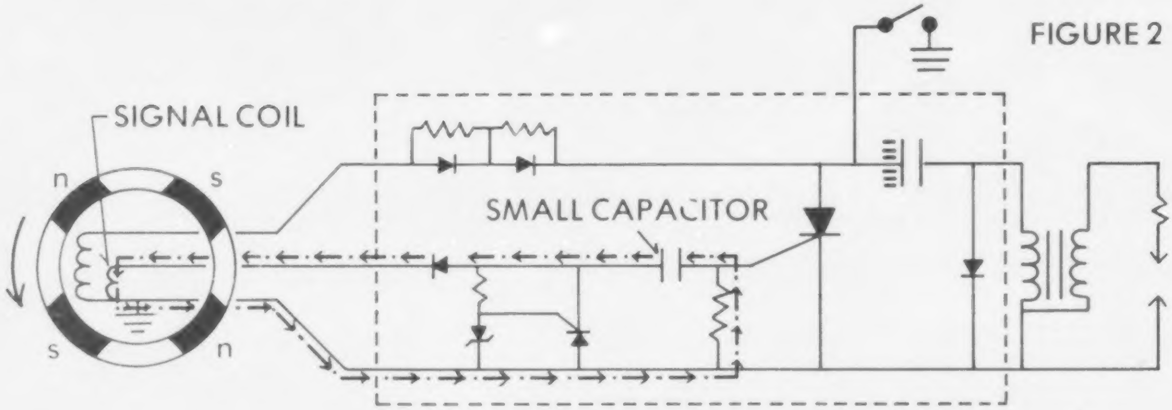

SIGNAL COIL
n
s
SMALL CAPACITOR
s
n

FIGURE 2

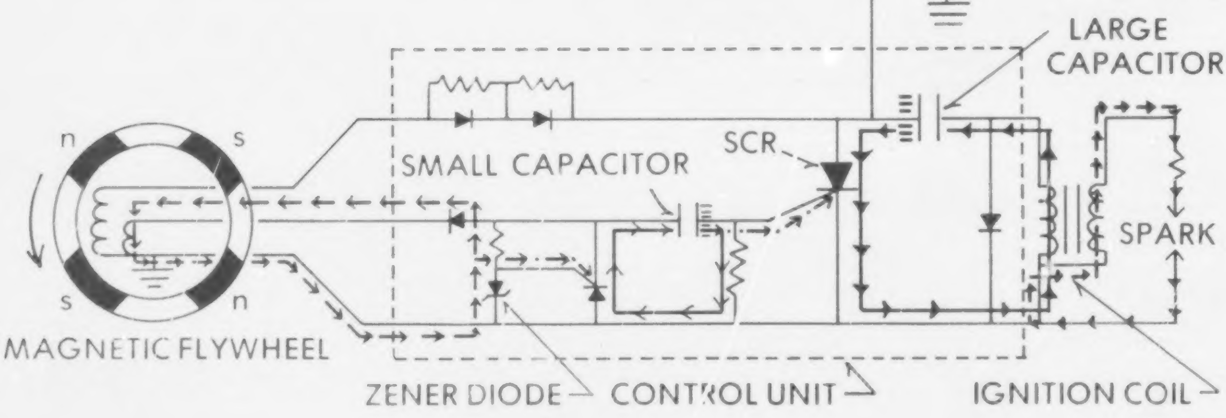

LARGE CAPACITOR
n
s
SCR
SMALL CAPACITOR
SPARK
s
n
MAGNETIC FLYWHEEL
ZENER DIODE
CONTROL UNIT
IGNITION COIL

FIGURE 3

## CAPACITOR DISCHARGE IGNITION SYSTEMS
## UNIT V

## JOB SHEET #1–TEST EXCITER AND SIGNAL COILS

I. Tools and materials

   A. Hand tool assortment

   B. Appropriate flywheel puller

   C. Metric socket wrench set

   D. Ohmmeter

   E. Appropriate service manual

   F. Safety glasses

II. Procedure

   A. Remove side covers to expose alternator

   B. Remove magnetic flywheel

   C. Disconnect exciter and signal coil leads from CDI control unit

   D. Connect the ohmmeter across the lead of the exciter coil and ground (Figure 1)

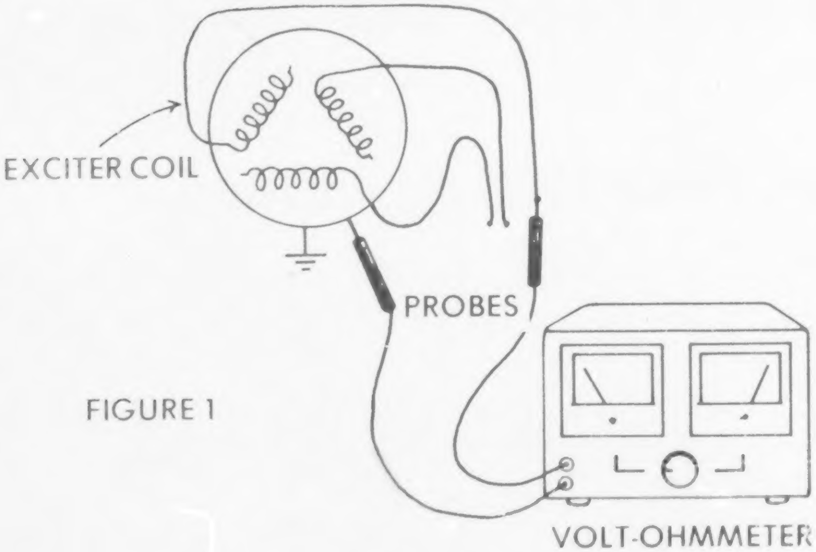


FIGURE 1

## JOB SHEET #1

E. Test resistance

(NOTE: The resistance should be 200 - 300 ohms. Consult service manual for your motorcycle make and model.)

F. Connect the ohmmeter from the pulsar (signal) coil lead and to ground (Figure 2)

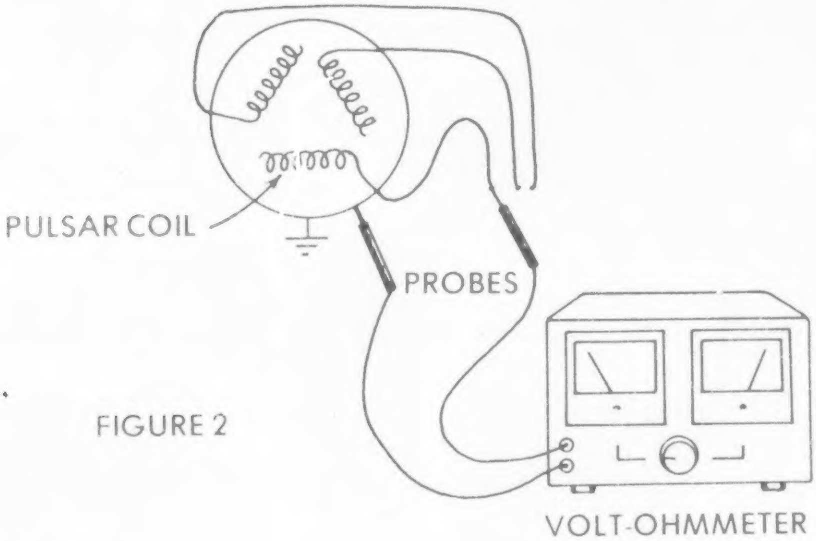


FIGURE 2

G. Test resistance

(NOTE: The resistance should be 75 - 150 ohms. Consult your service manual.)

# CAPACITOR DISCHARGE IGNITION SYSTEMS
## UNIT V

## JOB SHEET #2--TEST IGNITION COIL

I. Tools and materials

  A. Hand tool assortment

  B. Ohmmeter

  C. Appropriate service manual

  D. Safety glasses

II. Procedure

  A. Disconnect coil primary lead from CDI control unit

  B. Connect the ohmmeter from the disconnected coil primary lead to the coil primary ground lead (Figure 1)

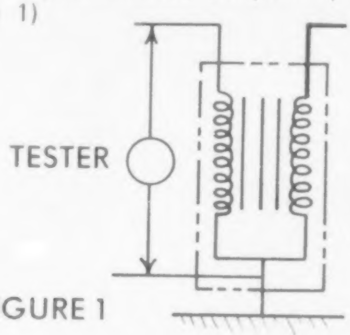


FIGURE 1

  C. Test resistance

  (NOTE: The resistance of the primary winding should be approximately .5 to 1.5 ohms. Consult your service manual.)

  D. Connect the ohmmeter from the coil secondary (spark plug) lead to the coil primary ground lead (Figure 2)

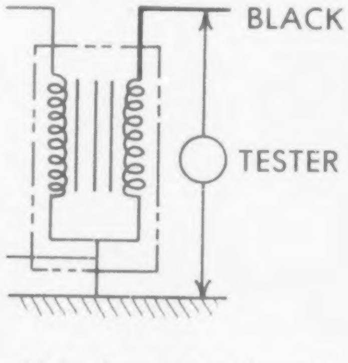


FIGURE 2

  E. Test resistance

  (NOTE: The secondary resistance should be from approximately 12,000 to 20,000 ohms. Consult your service manual.)

## CAPACITOR DISCHARGE IGNITION SYSTEMS
## UNIT V

NAME ______________________________

## TEST

1. Match the terms on the right to the correct definitions.

_____a. Circuit that triggers the SCR or thyristor and allows the capacitor to discharge

_____b. Circuits and components using semiconductors

_____c. Capacitor discharge ignition

_____d. Type of electronic switching device similar to transistors and SCRs

_____e. Special generating coil in the alternator that provides the capacitor with charging voltage

_____f. Semiconductive device which conducts when a specific current is applied and does not conduct when the specific current is removed

_____g. Special generating coil in the alternator that provides the signal voltage to activate the SCR or thyristor

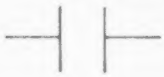
_____h. Device consisting of two conducting surfaces separated by an insulating material that will absorb and hold a charge of electricity until discharged

_____i. Any of a class of solids whose conductivity is between that of a conductor and that of an insulator

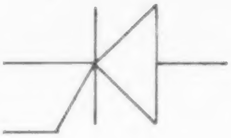
1. Capacitor
2. Thyristor
3. Signal coil
4. CDI
5. Transistor
6. Solid state
7. Exciter coil
8. Semiconductor
9. Trigger circuit

2. Match the terms on the right to the correct symbols.

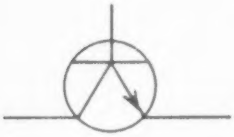
______a.



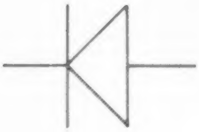
______b.



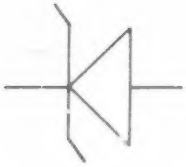
______c.



______d.



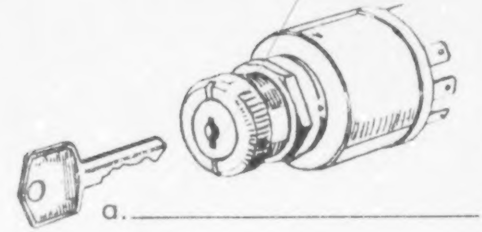
______e.



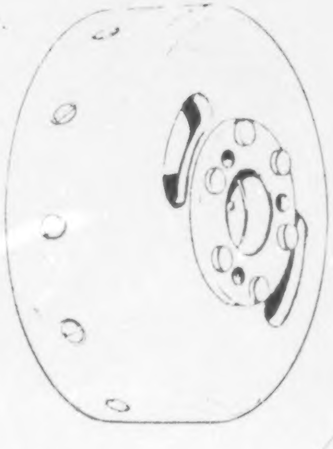
1. Zener Diode
2. Capacitor
3. Diode
4. Transistor
5. Silicon Controlled Rectifier (SCR

3. Discuss the advantages of the CDI system.

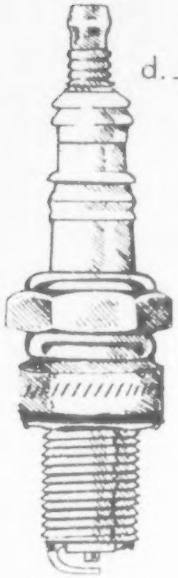
4. Identify the major components of the CDI system.



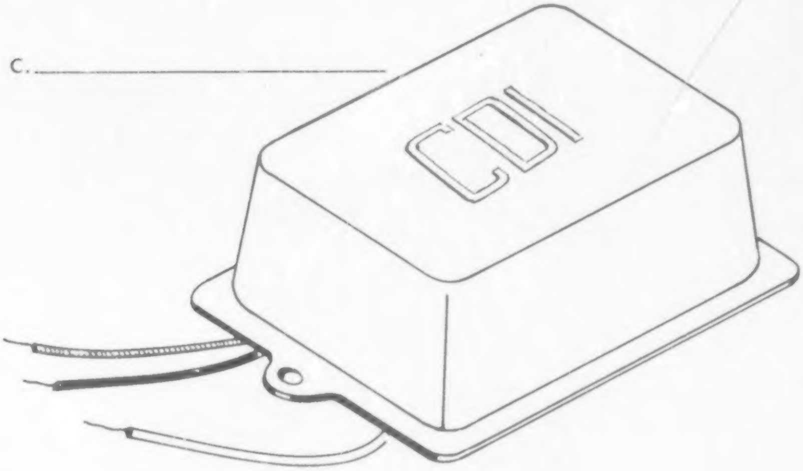
a. ______________________________



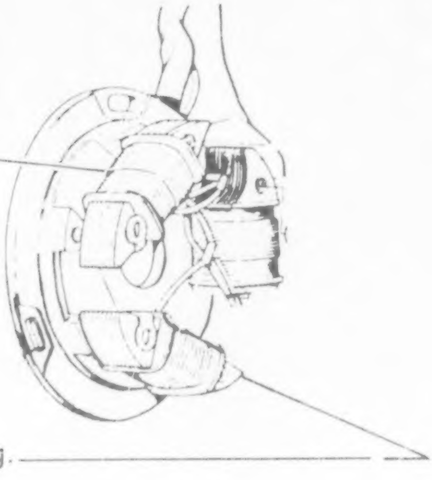
b. ______________________________



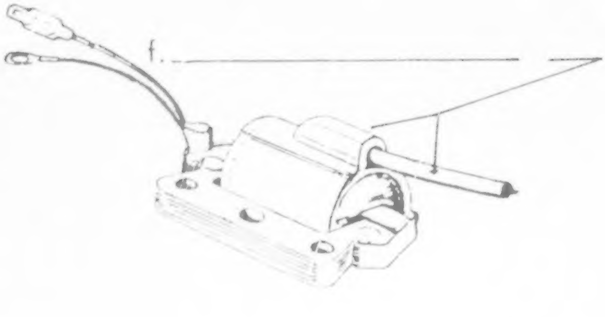
d. ______________________________



c. ______________________________



e. ______________________________



f. ______________________________

g. ______________________________

5. Arrange in order the steps in the operation of the CDI system by placing the correct sequence number in the appropriate blank.

_____a. Predetermined high voltage in signal coil opens a circuit through zener diode and sends voltage to small SCR

_____b. Very high voltage spark produced at spark plug

_____c. Magnetic flywheel generates alternating current in exciter coil

_____d. High voltage from capacitor builds very strong and rapid magnetic field

_____e. Alternating current also generated in signal coil

_____f. Rectified current charges large capacitor to approximately 300 V

_____g. High voltage from large capacitor discharged through primary windings of ignition coil

_____h. Current is rectified by one or more diodes

_____i. Strong primary voltage induces strong secondary voltage

_____j. Large SCR triggers large capacitor

_____k. Current charges small capacitor in trigger circuit

_____l. SCR triggers small capacitor to discharge and activate gate on large SCR

6. Demonstrate the ability to:

a. Test exciter and signal coils.

b. Test ignition coil.

(NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

## CAPACITOR DISCHARGE IGNITION SYSTEMS
## UNIT V

### ANSWERS TO TEST

1. a. 9
   b. 6
   c. 4
   d. 2
   e. 7
   f. 5
   g. 3
   h. 1
   i. 8

2. a. 2
   b. 5
   c. 4
   d. 3
   e. 1

3. Discussion should include:
   a. No moving parts in contact
      1) No wear
      2) Reduced maintenance
      3) Greater durability
      4) Accurate and consistant timing
   b. Higher voltage to the spark plug
      1) Eliminates plug fouling
      2) Improves high RPM performance

4. a. Ignition switch
   b. Magnetic flywheel
   c. Control unit
   d. Spark plug
   e. Exciter coil
   f. Ignition coil and secondary cable
   g. Signal coil

5. a. 6
   b. 12
   c. 1
   d. 10
   e. 4
   f. 3
   g. 9
   h. 2
   i. 11
   j. 8
   k. 5
   l. 7

6. Performance skills evaluated to the satisfaction of the instructor

# ELECTRICAL STARTING SYSTEMS
# UNIT VI

## UNIT OBJECTIVE

After completion of this unit, the student should be able to list the components of an electrical starting system and arrange in order the steps in the operation of this system. The student should also be able to trace circuits on a wiring diagram and test starter circuits. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define terms associated with electrical starting systems.
2. List seven components of an electrical starting system.
3. Describe the operation of the solenoid.
4. Arrange in order the steps in the operation of the starting system.
5. Describe the operation of the overrunning clutch.
6. Demonstrate the ability to:
    a. Trace starter circuits on a wiring diagram.
    b. Test starter circuits.

# ELECTRICAL STARTING SYSTEMS
## UNIT VI

## SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information, assignment, and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information and assignment sheets.

  F. Demonstrate and discuss the procedure outlined in the job sheet.

  G. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet

  C. Complete assignment and job sheets.

  D. Complete activities assigned by instructor.

  E. Take test.

## INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Starting System Components

    2. TM 2--Solenoid Operation

    3. TM 3--Overrunning Clutch
    4. TM 4--Starter Circuits

D. Assignment Sheet #1--Trace Starter Circuits on a Wiring Diagram

E. Answers to assignment sheet

F. Job Sheet #1--Test Starter Circuits

G. Test

H. Answers to test

II. References:

A. *Suzuki GT 550 Service Manual.* Suzuki Motor Co., Ltd., 1973.

B. *Suzuki Constructions and Works of Electrical Equipments.* Suzuki Motor Co., Ltd.

C. *Honda 750 Service Manual.* Honda Motor Co., Ltd., 1971.

D. *Honda 250-350 Service Manual.* Honda Motor Co., Ltd., 1972.

E. *Chilton's New Motorcycle Troubleshooting Guide.* Radnor, Pennsylvania: Chilton Book Co., 1973.

# ELECTRICAL STARTING SYSTEMS
## UNIT VI

## INFORMATION SHEET

I. Terms and definitions

   A. Solenoid--Cylindrical coil of wire with a movable iron core that is drawn into the center of the coil when electrical current is passed through the wire

   B. Overrunning clutch--Mechanical device which is constructed to transmit power in one direction of rotation only

II. Components of an electrical starting system (Transparency 1)

   A. Starter motor

   B. Starter solenoid

   C. Battery

   D. Main switch

   (NOTE: This is also known as a combination switch.)

   E. Starter button

   F. High amperage wires

   G. Low amperage wires

III. Operation of solenoid (Transparency 2)

   A. Operator activates main switch

      1. Connects battery to solenoid field windings

      2. No current flow because field windings not grounded

   B. Operator activates starter button to ground solenoid field windings

      1. Current flow in field windings creates strong magnetic field

      2. Magnetic field pulls plunger through coil

      3. Disc connected to plunger contacts both battery cable terminals

      4. High amperage current can now flow from battery through solenoid to starter motor

## INFORMATION SHEET

IV. Operation of starting system (Transparency 1)

   A. Operator activates main switch

   B. Operator activates starter button

   C. Solenoid closes

   D. High amperage current flows from battery to starter motor

   E. Starter motor rotates

   F. Overrunning clutch transmits starter motor rotation to engine

V. Operation of overrunning clutch (Transparency 3)

   A. Inner race connected to starter motor shaft

   B. Outer race connected directly or indirectly to engine crankshaft

   (NOTE: Outer race is connected to crankshaft on some machines and to the clutch on others.)

   C. Hardened steel rollers move in tapered recesses

   D. Forward rotation of starter motor shaft causes rollers to move toward narrow portion of recess

   E. Roller wedges between inner and outer races to lock races together

   F. Springs insure that rollers move to narrow part of recess

   G. Overspeed of outer unit as engine starts causes rollers to move to wide portion of recess

   H. Overspeed releases inner and outer races

VI. Tracing starter circuits on wiring diagram (Transparency 4)

   A. Tracing high amperage circuit

      1. Locate battery

      2. Locate solenoid

      3. Heavy battery cable connects battery and solenoid

## INFORMATION SHEET

4. Locate starter motor

5. Heavy battery cable connects solenoid and starter motor

6. Starter motor and battery both grounded to complete circuit

B. Tracing low amperage circuit

1. Locate starter solenoid

2. Locate main switch

3. Small gauge red wire connects battery side of starter solenoid to main switch

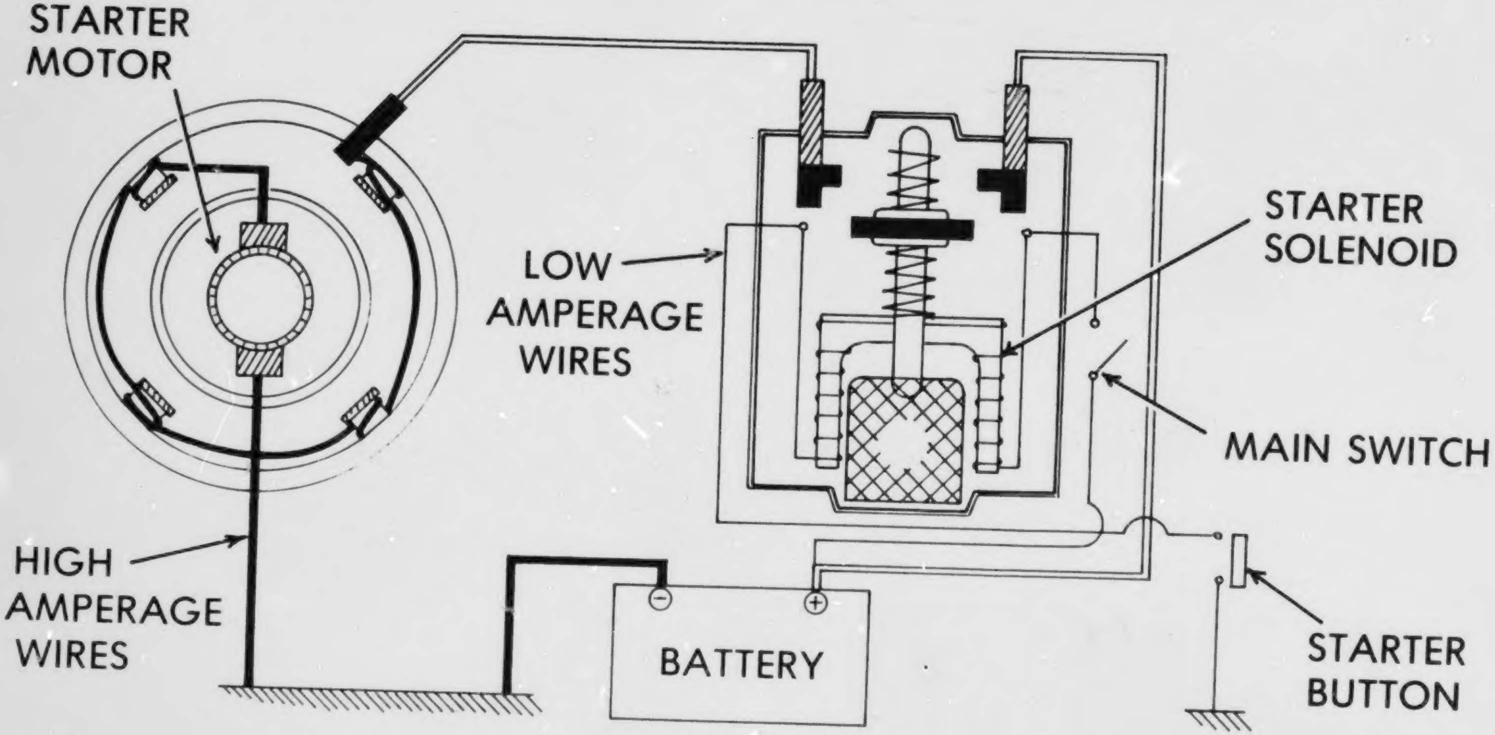
4. Small gauge black wire connects main switch to starter solenoid field coil

5. Locate starter button

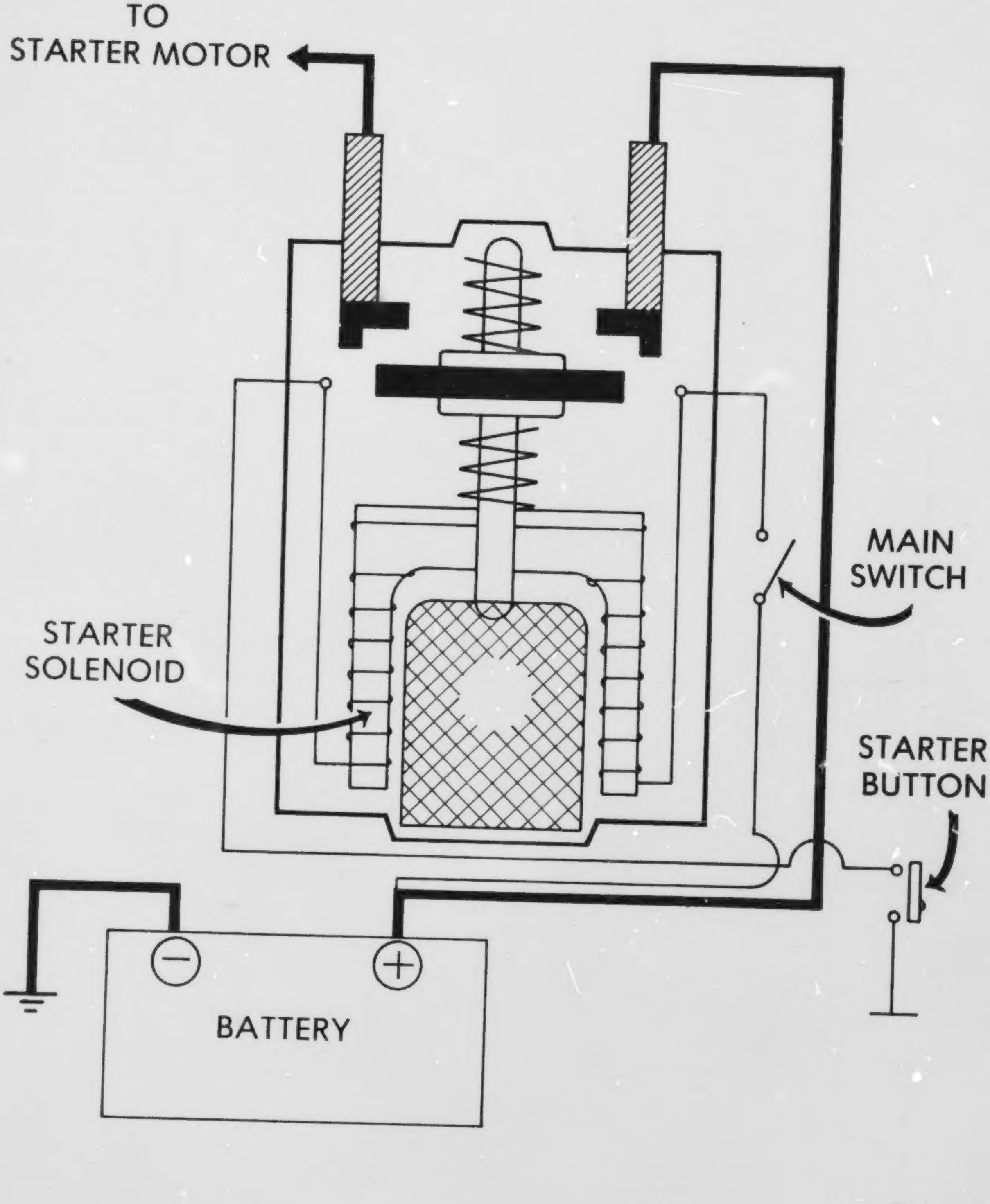
6. Small gauge yellow/red wire connects the other side of starter solenoid field coil to starter button

7. Starter button grounded to complete low amperage circuit

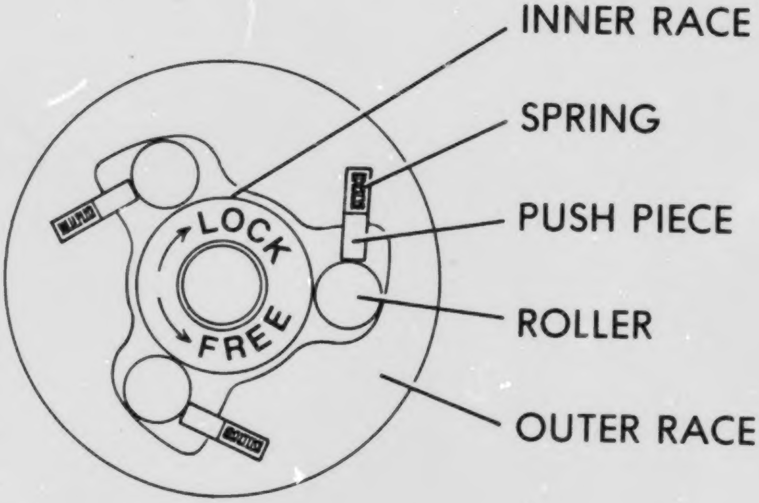
# STARTING SYSTEM COMPONENTS


STARTER MOTOR
LOW AMPERAGE WIRES
STARTER SOLENOID
MAIN SWITCH
HIGH AMPERAGE WIRES
BATTERY
STARTER BUTTON

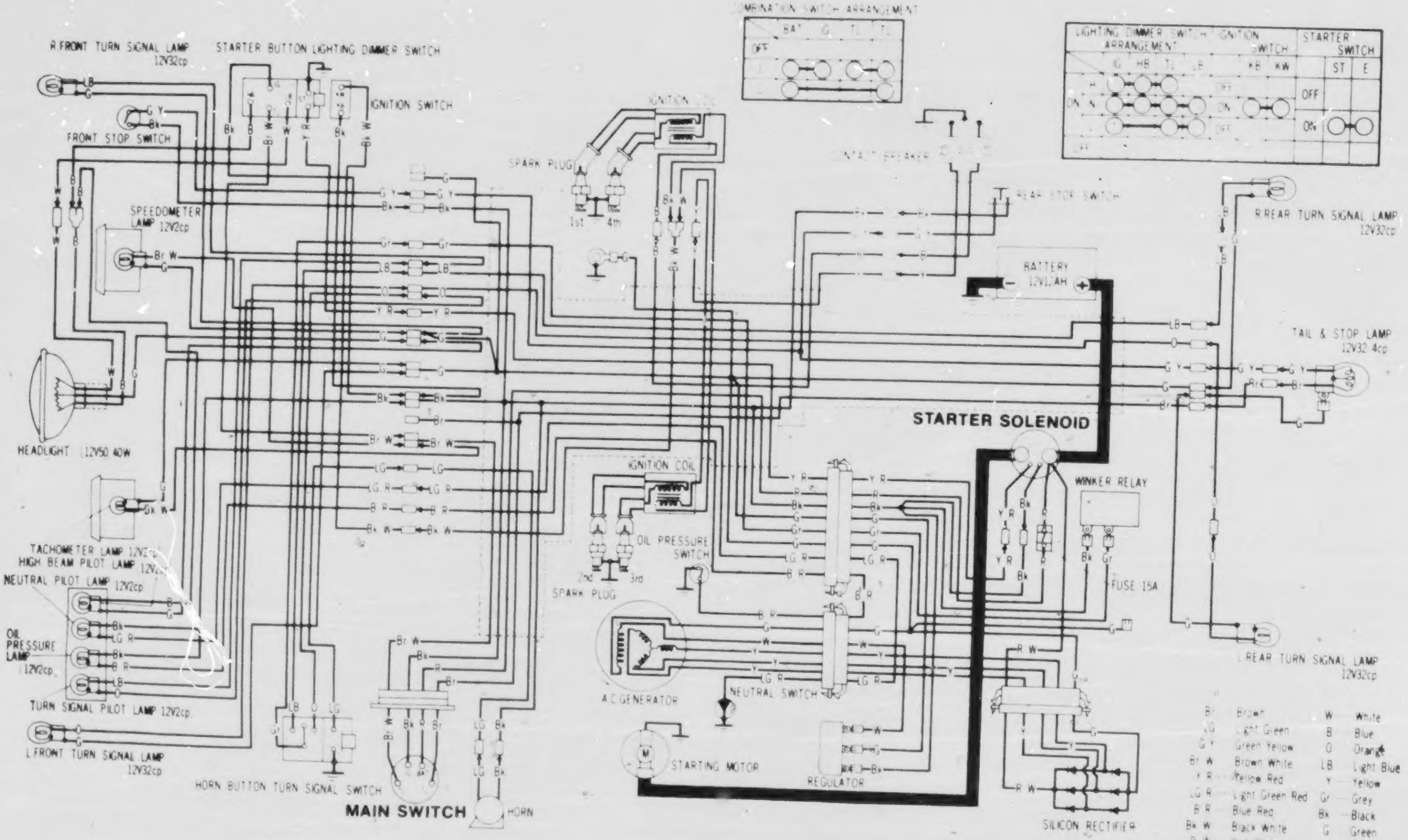
# SOLENOID OPERATION


TO
STARTER MOTOR
MAIN
SWITCH
STARTER
SOLENOID
STARTER
BUTTON
BATTERY

# OVERRUNNING CLUTCH


INNER RACE
SPRING
PUSH PIECE
ROLLER
OUTER RACE
LOCK
FREE

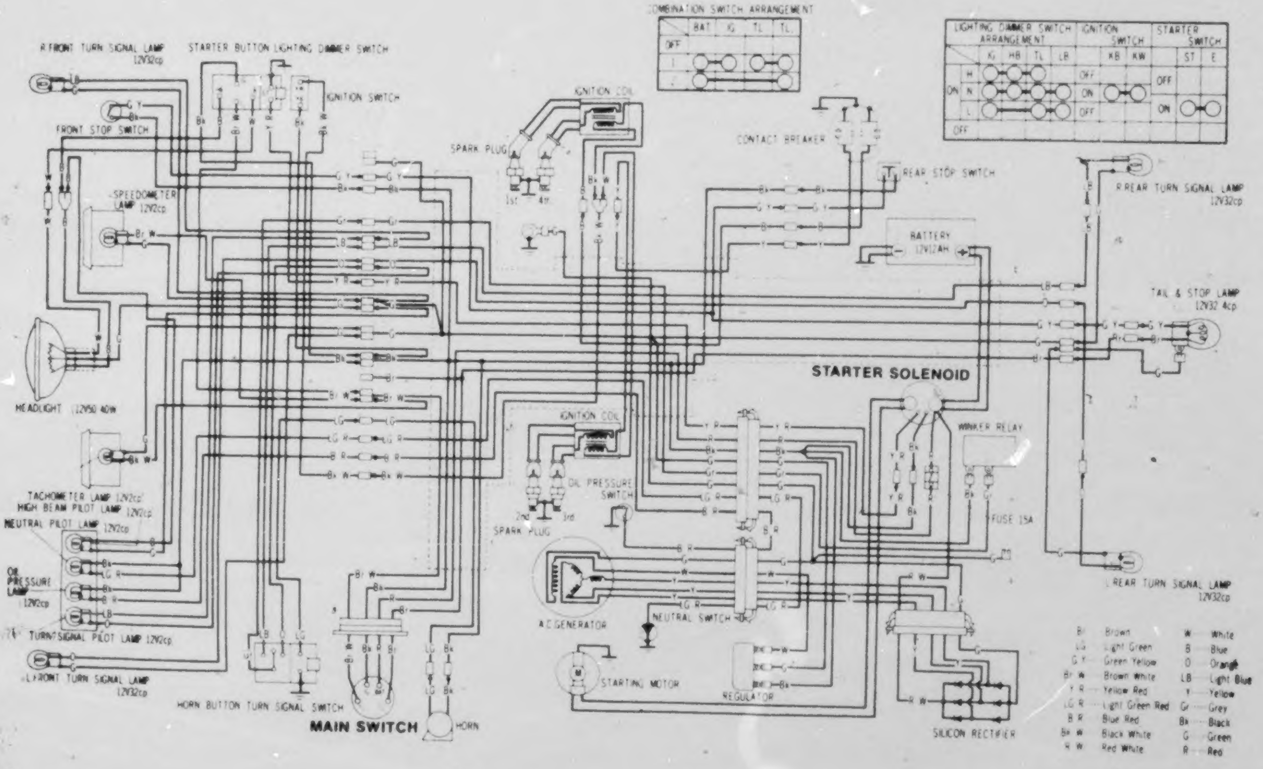
# STARTER CIRCUITS


R.FRONT TURN SIGNAL LAMP 12V32cp
STARTER BUTTON LIGHTING DIMMER SWITCH
IGNITION SWITCH
FRONT STOP SWITCH
SPEEDOMETER LAMP 12V2cp
HEADLIGHT 12V50 40W
TACHOMETER LAMP 12V2cp
HIGH BEAM PILOT LAMP 12V2cp
NEUTRAL PILOT LAMP 12V2cp
OIL PRESSURE LAMP 12V2cp
TURN SIGNAL PILOT LAMP 12V2cp
L.FRONT TURN SIGNAL LAMP 12V32cp
HORN BUTTON TURN SIGNAL SWITCH
MAIN SWITCH
HORN
IGNITION COIL
SPARK PLUG
1st
4th
2nd
3rd
OIL PRESSURE SWITCH
A.C.GENERATOR
NEUTRAL SWITCH
STARTING MOTOR
REGULATOR
COMBINATION SWITCH ARRANGEMENT
BAT
IG
TL
TL
OFF
CONTACT BREAKER
REAR STOP SWITCH
BATTERY 12V12AH
STARTER SOLENOID
WINKER RELAY
FUSE 15A
SILICON RECTIFIER
LIGHTING DIMMER SWITCH ARRANGEMENT
IGNITION SWITCH
STARTER SWITCH
IG
HB
TL
LB
KB
KW
ST
E
H
N
ON
OFF
R.REAR TURN SIGNAL LAMP 12V32cp
TAIL & STOP LAMP 12V32 4cp
L.REAR TURN SIGNAL LAMP 12V32cp
Br Brown
LG Light Green
G Y Green Yellow
Br W Brown White
Y R Yellow Red
LG R Light Green Red
B R Blue Red
Bk W Black White
R W Red White
W White
B Blue
O Orange
LB Light Blue
Y Yellow
Gr Grey
Bk Black
G Green
R Red

# ELECTRICAL STARTING SYSTEMS
## UNIT VI

## ASSIGNMENT SHEET #1--TRACE STARTER CIRCUITS ON A WIRING DIAGRAM

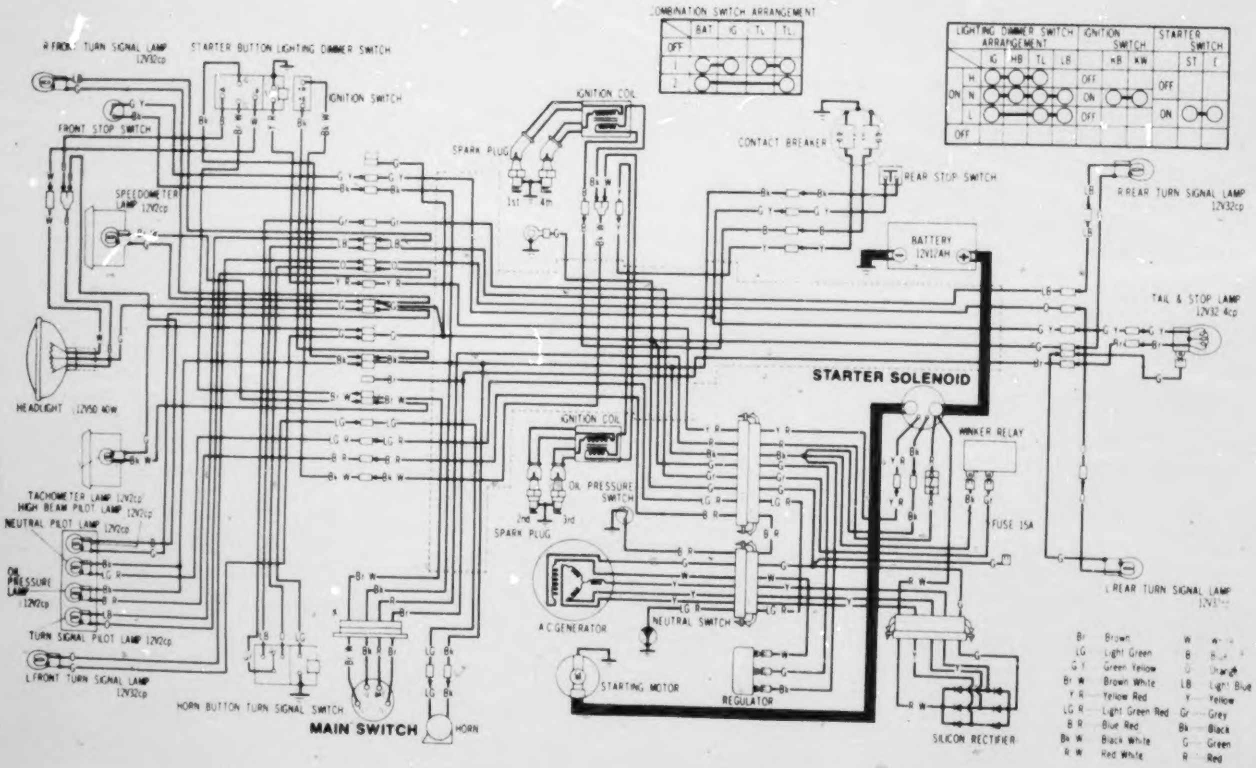
1. Trace the high amperage circuit by marking the correct wires on the diagram in black ink.
2. Trace the low amperage circuit by marking the correct wires on the diagram in red ink.


COMBINATION SWITCH ARRANGEMENT
BAT
IG
TL
OFF
LIGHTING DIMMER SWITCH ARRANGEMENT
IG
HB
TL
LB
H
N
L
ON
OFF
IGNITION SWITCH
KB
KW
OFF
ON
STARTER SWITCH
ST
E
R FRONT TURN SIGNAL LAMP 12V32cp
STARTER BUTTON LIGHTING DIMMER SWITCH
IGNITION SWITCH
FRONT STOP SWITCH
SPEEDOMETER LAMP 12V2cp
IGNITION COIL
SPARK PLUG
1st
4th
CONTACT BREAKER
REAR STOP SWITCH
R REAR TURN SIGNAL LAMP 12V32cp
BATTERY 12V12AH
TAIL & STOP LAMP 12V32 4cp
HEADLIGHT 12V50 40W
STARTER SOLENOID
WINKER RELAY
IGNITION COIL
OIL PRESSURE SWITCH
2nd
3rd
SPARK PLUG
TACHOMETER LAMP 12V2cp
HIGH BEAM PILOT LAMP 12V2cp
NEUTRAL PILOT LAMP 12V2cp
OIL PRESSURE LAMP 12V2cp
TURN SIGNAL PILOT LAMP 12V2cp
L FRONT TURN SIGNAL LAMP 12V32cp
FUSE 15A
L REAR TURN SIGNAL LAMP 12V32cp
A.C GENERATOR
NEUTRAL SWITCH
STARTING MOTOR
REGULATOR
HORN BUTTON TURN SIGNAL SWITCH
MAIN SWITCH
HORN
SILICON RECTIFIER
Br — Brown
LG — Light Green
G Y — Green Yellow
Br W — Brown White
Y R — Yellow Red
LG R — Light Green Red
B R — Blue Red
Bk W — Black White
R W — Red White
W — White
B — Blue
O — Orange
LB — Light Blue
Y — Yellow
Gr — Grey
Bk — Black
G — Green
R — Red

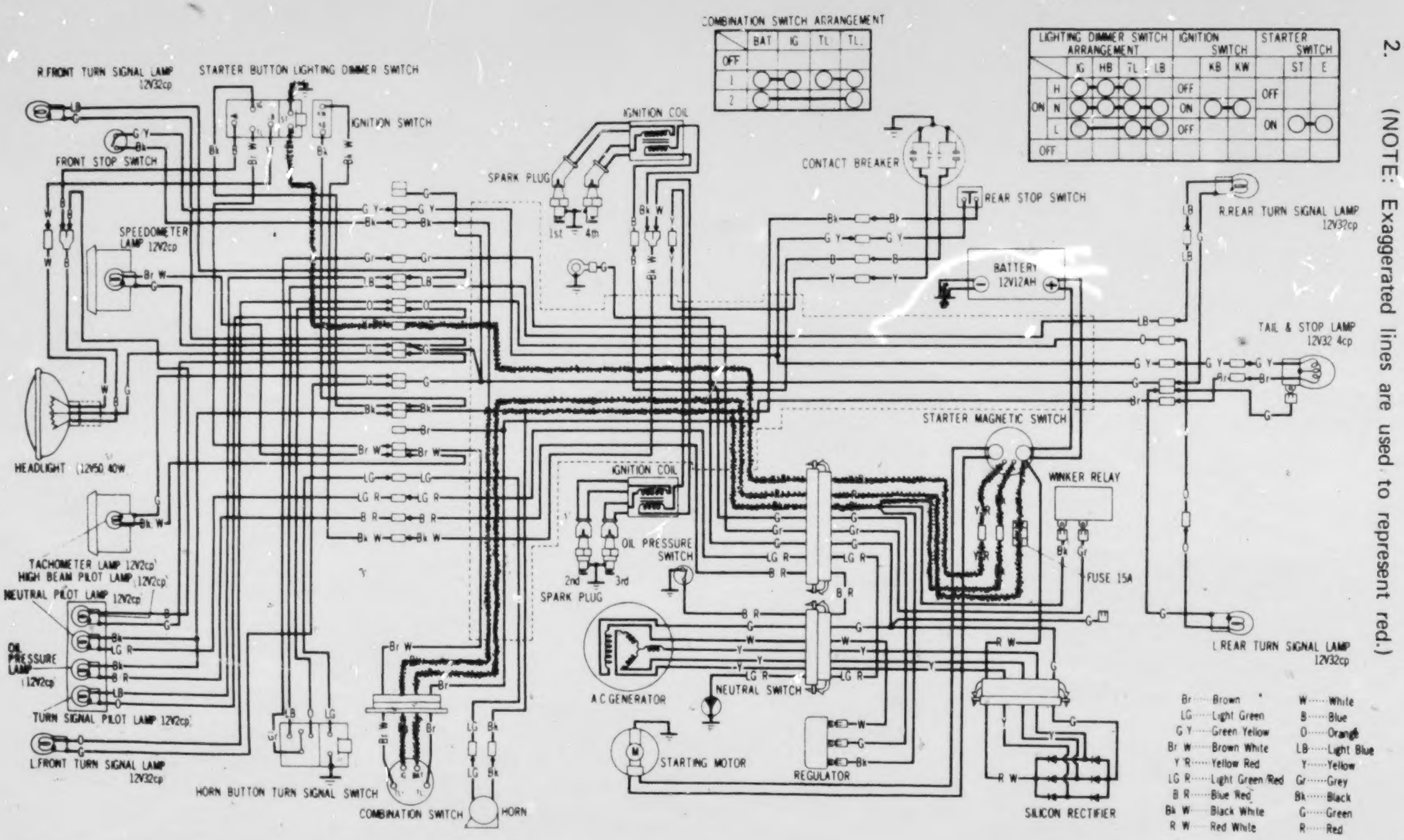
# ELECTRICAL STARTING SYSTEMS
# UNIT VI

## ANSWERS TO ASSIGNMENT SHEET

1.


R FRONT TURN SIGNAL LAMP 12V32cp
STARTER BUTTON
LIGHTING DIMMER SWITCH
IGNITION SWITCH
FRONT STOP SWITCH
SPEEDOMETER LAMP 12V2cp
HEADLIGHT 12V50 40W
TACHOMETER LAMP 12V2cp
HIGH BEAM PILOT LAMP 12V2cp
NEUTRAL PILOT LAMP 12V2cp
OIL PRESSURE LAMP 12V2cp
TURN SIGNAL PILOT LAMP 12V2cp
L FRONT TURN SIGNAL LAMP 12V32cp
HORN BUTTON
TURN SIGNAL SWITCH
MAIN SWITCH
HORN
IGNITION COIL
SPARK PLUG
1st
4th
2nd
3rd
OIL PRESSURE SWITCH
A.C GENERATOR
NEUTRAL SWITCH
STARTING MOTOR
REGULATOR
COMBINATION SWITCH ARRANGEMENT
BAT
IG
TL
TL
OFF
1
2
CONTACT BREAKER
REAR STOP SWITCH
BATTERY 12V12AH
STARTER SOLENOID
WINKER RELAY
FUSE 15A
SILICON RECTIFIER
LIGHTING DIMMER SWITCH ARRANGEMENT
IG
HB
TL
LB
H
N
L
ON
OFF
IGNITION SWITCH
STARTER SWITCH
ST
E
R REAR TURN SIGNAL LAMP 12V32cp
TAIL & STOP LAMP 12V32 4cp
L REAR TURN SIGNAL LAMP 12V32cp
Br Brown
LG Light Green
G Y Green Yellow
Br W Brown White
Y R Yellow Red
LG R Light Green Red
B R Blue Red
Bk W Black White
R W Red White
W White
B Blue
O Orange
LB Light Blue
Y Yellow
Gr Grey
Bk Black
G Green
R Red

2. (NOTE: Exaggerated lines are used to represent red.)


COMBINATION SWITCH ARRANGEMENT
BAT
IG
TL
TL.
OFF
1
2
LIGHTING DIMMER SWITCH ARRANGEMENT
IG
HB
TL
LB
ON
H
N
L
OFF
IGNITION SWITCH
OFF
ON
OFF
KB
KW
STARTER SWITCH
ST
E
OFF
ON
R.FRONT TURN SIGNAL LAMP 12V32cp
STARTER BUTTON LIGHTING DIMMER SWITCH
IGNITION SWITCH
FRONT STOP SWITCH
SPEEDOMETER LAMP 12V2cp
HEADLIGHT 12V50 40W
TACHOMETER LAMP 12V2cp
HIGH BEAM PILOT LAMP 12V2cp
NEUTRAL PILOT LAMP 12V2cp
OIL PRESSURE LAMP 12V2cp
TURN SIGNAL PILOT LAMP 12V2cp
L.FRONT TURN SIGNAL LAMP 12V32cp
HORN BUTTON TURN SIGNAL SWITCH
COMBINATION SWITCH
HORN
IGNITION COIL
SPARK PLUG
1st
4th
2nd
3rd
OIL PRESSURE SWITCH
A.C.GENERATOR
NEUTRAL SWITCH
STARTING MOTOR
REGULATOR
CONTACT BREAKER
REAR STOP SWITCH
BATTERY 12V12AH
R.REAR TURN SIGNAL LAMP 12V32cp
TAIL & STOP LAMP 12V32 4cp
STARTER MAGNETIC SWITCH
WINKER RELAY
FUSE 15A
SILICON RECTIFIER
L.REAR TURN SIGNAL LAMP 12V32cp
G Y
Bk
Gr
LB
O
G
Br
Br W
LG
LG R
B R
Bk W
W
B
Y
Y R
R W

| | | | |
|---|---|---|---|
| Br | Brown | W | White |
| LG | Light Green | B | Blue |
| G Y | Green Yellow | O | Orange |
| Br W | Brown White | LB | Light Blue |
| Y R | Yellow Red | Y | Yellow |
| LG R | Light Green/Red | Gr | Grey |
| B R | Blue Red | Bk | Black |
| Bk W | Black White | G | Green |
| R W | Red White | R | Red |

# ELECTRICAL STARTING SYSTEMS
# UNIT VI

## JOB SHEET #1--TEST STARTER CIRCUITS

I. Tools and materials

A. Motorcycle equipped with an electric starter motor circuit

(NOTE: The electric starter should not be the combination starter/generator system that is used on many motorcycles.)

B. DC voltmeter

C. Appropriate service manual

D. Hand tool assortment

E. Paper and pencil

F. Safety glasses

II. Procedure

(NOTE: Even though the starter circuit may be operating, the testing procedure can be performed as though a malfunction did exist by disconnecting the starter cable from the motor terminal.)

A. Connect the (+) voltmeter lead to the (+) battery terminal, and connect the (-) voltmeter lead to the (-) battery terminal

B. Read and record the battery voltage

C. Connect the (+) voltmeter lead to the battery terminal of the starter solenoid

D. Read and record the voltage

(NOTE: This reading should be the same as the battery voltage reading; if the voltage is less, there is a faulty cable or connection.)

E. Connect the (+) voltmeter lead to the starter motor terminal of the solenoid

F. Operate the starter switch and button

(NOTE: The voltmeter should read the same as before.)

G. Record the reading

(NOTE: If the reading is lower than before, it could indicate high resistance in the solenoid plunger and cable terminals. No reading at all could indicate no contact within the solenoid or a faulty solenoid field coil; diagnosis of this problem begins with step J.)

## JOB SHEET #1

H. Connect the (+) voltmeter lead to the starter cable at the starter motor end, and operate the starter switch and button

I. Read and record the voltage

(NOTE: It should be the same as previous tests. A lower reading or no reading at all indicates a faulty cable between the solenoid and starter motor. If test indicates current flow but the starter does not operate, the problem is in the starter motor itself.)

J. Test the low amperage circuit by connecting the (+) voltmeter lead to the battery wire terminal of the main switch

K. Read and record the voltage

(NOTE: A lower than battery voltage reading indicates a faulty wire or connections. No reading at all could mean a blown fuse. Check it before proceeding.)

L. Disconnect the switch wire from the solenoid and connect the (+) voltmeter lead to the solenoid terminal of the main switch

M. Turn on the switch

O. Read and record the voltage

(NOTE: It should be the same as the previous tests. If there is no reading, the combination switch is faulty.)

P. Connect the (+) voltmeter lead to the disconnected switch wire at the solenoid

Q. Turn on the combination switch and press the starter button

R. Read and record the voltage

(NOTE: If the solenoid is externally grounded, the starter button need not be pressed to get a reading. No reading could indicate a faulty wire, connections, or starter button. The starter button would apply to the internally grounded solenoid only.)

S. If test indicates current flow but the solenoid fails to operate, check grounding of the solenoid

# ELECTRICAL STARTING SYSTEMS
## UNIT VI

NAME ______________________________

## TEST

1. Define the terms associated with electrical starting systems.
   a. Solenoid--
   b. Overrunning clutch--

2. List seven components of an electrical starting system.
   a.
   b.
   c.
   d.
   e.
   f.
   g.

3. Describe the operation of the solenoid.

4. Arrange in order the following steps in the operation of the starting system by placing the correct sequence number in the appropriate blank.

   ______a. Starter motor rotates

   ______b. Operator activates main switch

   ______c. Solenoid closes

   ______d. Overrunning clutch transmits starter motor rotation to engine

   ______e. High amperage current flows from battery to starter motor

   ______f. Operator activates starter button

5. Describe the operation of the overrunning clutch.

6. Demonstrate the ability to:

   a. Trace starter circuits on a wiring diagram.

   b. Test starter circuits.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

# ELECTRICAL STARTING SYSTEMS
## UNIT VI

## ANSWERS TO TEST

1. a. Solenoid--Cylindrical coil of wire with a movable iron core that is drawn into the center of the coil when electrical current is passed through the wire

   b. Overrunning clutch--Mechanical device which is constructed to transmit power in one direction of rotation only

2. a. Starter motor

   b. Starter solenoid

   c. Battery

   d. Main switch

   e. Starter button

   f. High amperage wires

   g. Low amperage wires

3. Description should include:

   a. Operator activates main switch

      1) Connects battery to solenoid field windings

      2) No current flow because solenoid field windings not grounded

   b. Operator activates starter button to ground solenoid field windings

      1) Current flow in field windings creates strong magnetic field

      2) Magnetic field pulls plunger through coil

      3) Disc connected to plunger contacts both battery cable terminals

      4) High amperage current can now flow from battery through solenoid to starter motor

4. a. 5

   b. 1

   c. 3

   d. 6

   e. 4

   f. 2

5. Description should include:
    a. Inner race connected to starter motor shaft
    b. Outer race connected directly or indirectly to engine crankshaft
    c. Hardened steel rollers move in tapered recesses
    d. Forward rotation of starter motor shaft causes rollers to move toward narrow portion of recess
    e. Roller wedges between inner and outer races to lock races together
    f. Springs insure that rollers move to narrow part of recess
    g. Overspeed of outer unit as engine starts causes rollers to move to wide portion of recess
    h. Overspeed releases inner and outer races
6. Performance skills evaluated to the satisfaction of the instructor.

# SLIDE VALVE CARBURETORS
## UNIT I

## UNIT OBJECTIVE

After completion of this unit, the student should be able to distinguish between the two types of slide valve carburetors, identify the major parts of each type, and describe the operations of the slide valve carburetor systems. The student should also be able to disassemble, service, and reassemble a slide valve carburetor. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with slide valve carburetors to the correct definitions.
2. Distinguish between direct control and constant velocity slide valve carburetors.
3. Match the location of the parts of a direct control carburetor to the correct part names.
4. Match the location of the parts of a constant velocity carburetor to the correct part names.
5. Select the systems of a slide valve carburetor.
6. Describe the operation of the float system.
7. Describe the operation of the starter system.
8. Describe the operation of the pilot and intermediate speed system.
9. Describe the operation of the main system.
10. Discuss the differences in operation between the two types of slide valve carburetors.
11. Demonstrate the ability to:
    a. Disassemble, service, and reassemble a slide valve carburetor.
    b. Adjust idle speed and mixture on a slide valve carburetor.

## SLIDE VALVE CARBURETORS
## UNIT I

### SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss the procedures outlined in the job sheets.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheets.

   D. Complete activities assigned by instructor.

   E. Take test.

### INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Types of Slide Valve Carburetors

      2. TM 2--Direct Control Carburetor Parts

      3. TM 3--Constant Velocity Carburetor Parts

4. TM 4--Float System
5. TM 5--Starter System - Lever Operated
6. TM 6--Pilot and Intermediate Speed System
7. TM 7--Main System
8. TM 8--Main System - Throttle Opening Relationship
9. TM 9--Main System - Fuel Flow and Jet Needle Clearance

D. Job sheets

1. Job Sheet #1--Disassemble, Service, and Reassemble a Slide Valve Carburetor
2. Job Sheet #2--Adjust Idle Speed and Mixture on a Slide Valve Carburetor

E. Test

F. Answers to test

II. References:

A. *Honda Motorcycle and Power Products Training Manual.* Gardena, California: American Honda Motor Co., Inc., 1975.

B. *Honda 450 Service Manual.* Honda Motor Co., Ltd., 1971.

C. *Honda 250-350 Service Manual.* Honda Motor Co., Ltd., 1972.

D. *Chilton's New Motorcycle Troubleshooting Guide.* Radnor, Pennsylvania: Chilton Book Co., 1973.

E. *Suzuki New Type Carburetor Service Manual-Models GT380, GT550, and GT750.* Suzuki Motor Co., Ltd., 1974.

F. *Suzuki Service Manual-Carburetor and Carburetion.* Suzuki Motor Co., Ltd., 1974.

G. *U.S. Suzuki Technical Training Centers Training Handouts.* Suzuki Motor Co., Ltd., 1975.

H. *Motorcycle Systems Training Manual-Carburetors.* Kawasaki Motors Corp., 1973.

I. *Suzuki Service Manual-T250 and T350.* Suzuki Motor Co., Ltd., 1969.

# SLIDE VALVE CARBURETORS
## UNIT I

## INFORMATION SHEET

I. Terms and definitions

  A. Venturi--Narrowed section of the air passage of a carburetor which causes air speed to increase and air pressure to decrease

  B. Variable venturi valve (throttle slide valve)--Movable unit in the carburetor throat which controls amount of air which can enter the engine

  C. Jet needle--Tapered shaft connected to throttle slide valve which controls amount of fuel which may be drawn into engine in relation to slide valve position

  D. Pilot jet (idle or low speed jet)--Jet through which fuel flows during low and idle speeds

  E. Needle jet--Main control valve for fuel entering the air stream

  F. Emulsion tube--Perforated tube connected to pilot jet used to premix fuel and air

II. Types of slide valve carburetors (Transparency 1)

  A. Direct control

  B. Constant velocity

III. Parts of direct control carburetor (Transparency 2)

  A. Cable adjuster boot

  B. Cable adjuster and nut

  C. Cap

  D. Cap o-ring

  E. Throttle return spring

  F. Jet needle retainer spring

  G. Jet needle clip

  H. Jet needle

  I. Throttle slide valve

## INFORMATION SHEET

J. Needle jet

K. Carburetor upper body

L. Pilot adjusting screw and spring

M. Idle speed screw, o-ring, and spring

N. Needle valve gasket

O. Needle valve and seat

P. Main jet and gasket

Q. Pilot jet

R. Float bowl gasket

S. Float assembly

T. Float pin

U. Float bowl

V. Drain plug and gasket

W. Starter valve cable adjuster boot

X. Starter valve cable adjuster and locknut

Y. Starter valve o-ring

Z. Starter valve spring

AA. Starter valve

IV. Parts of constant velocity carburetor (Transparency 3)

A. Vacuum piston cover

B. Vacuum piston and slide valve

C. Vacuum piston gasket

D. Jet needle

E. Idle speed screw and spring

F. Carburetor upper body

## INFORMATION SHEET

- G. Choke valve
- H. Float valve assembly or needle valve and seat
- I. Float pin
- J. Float
- K. Float bowl
- L. Float bowl retainer
- M. Drain plug and gasket
- N. Float bowl gasket
- O. Main jet
- P. Needle jet and discharge nozzle
- Q. Pilot jet
- R. Slow jet
- S. Pilot port plug
- T. Pilot adjusting screw, spring, and seals
- U. Throttle shaft and valve assembly
- V. Jet needle holder
- W. Jet needle set screw

V. Slide valve carburetor systems

- A. Float system
- B. Starter system
- C. Pilot and intermediate speed system
- D. Main system

VI. Operation of the float system (Transparency 4)

- A. Maintains supply of fuel for all other metering systems of carburetor

## INFORMATION SHEET

B. Fuel level controlled by the action of float and needle valve

1. Fuel level in bowl drops

   a. Float drops slightly

   b. Needle moves away from seat

   c. Fuel enters bowl

2. Fuel level in bowl rises

   a. Float rises

   b. Needle moves to contact seat

   c. Fuel flow to bowl shuts off

C. Fuel level is kept constant by continual self-adjustment

VII. Operation of the starter system (Transparency 5)

A. Provides extra rich fuel-air mixture for cold engine starts

B. Rich mixture discharge controlled by plunger in air passage

1. Plunger lifted off its seat

   a. High vacuum on engine side of closed slide valve pulls fuel from float bowl through pilot jet

   b. Fuel and air premixed in passage before entering carburetor throat

2. Plunger returned to its seat shuts off flow of fuel and air in the starter system

   (NOTE: The slide valve must be fully closed for the system to operate properly.)

VIII. Operation of the pilot and intermediate speed system (Transparency 6)

A. Meters fuel and air in the closed to 1/8 open throttle position

B. Pilot system operates with throttle slide valve in the idle (fully closed) position

1. Fuel is drawn through the pilot jet which protrudes into float chamber

## INFORMATION SHEET

2. Air enters through

   a. Pilot air passage

   b. Pilot by-pass

3. Air and fuel are premixed in the emulsion tube which is part of the pilot jet

4. Mixture is drawn out of pilot outlet to engine for idle operation

C. Intermediate system functions when throttle slide valve is raised off of seat

1. Larger volume of air passes through venturi

2. Pressure drops at opening of pilot by-pass

3. Pilot by-pass now discharges fuel along with pilot outlet

   (NOTE: Carburetors with a pilot adjusting screw on the air intake side of body are air adjustment. Carburetors with pilot adjusting screw on engine side are mixture adjustment.)

IX. Operation of the main system (Transparencies 7, 8, and 9)

A. Meters fuel and air from 1/8 to full throttle position

B. Different components in control at different throttle positions

1. Throttle slide valve cutaway provides major control in the 1/8 to 1/4 throttle range

   a. Higher cutaway--Leaner mixture

      1) Higher cutaway offers less resistance to incoming air

      2) Additional air flow with a constant fuel flow means a leaner mixture

   b. Lower cutaway--Richer mixture

   c. Cutaway size marked on bottom of throttle valve

      Example: 2.0 - 2.5 - 3.0

   d. Fuel flow change between cutaway sizes is greatest in the 25-50% throttle range

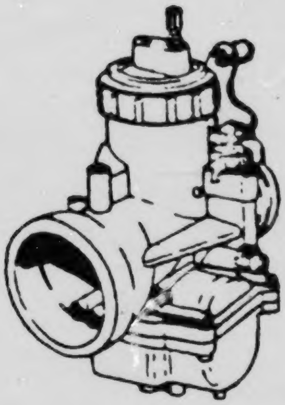
## INFORMATION SHEET

2. Jet needle and needle jet provide major control in the 1/4 to 3/4 throttle range
    a. Jet needle rises up out of needle jet as throttle slide valve is raised
    b. Tapered portion of needle arrives at upper end of jet at about 1/4 throttle
    c. Throttle positions of 1/4 and above cause
        1) Clearance between needle and jet to gradually increase
        2) More fuel to flow through jet
    d. Needle jet also preatomizes fuel
3. Main jet provides major control in the 3/4 to full throttle range
    a. Main jet determines the total fuel flow when the clearance between needle jet and jet needle becomes greater than the area of main jet
    b. Main jets available in three types, each with different numbering systems and standards for determining calibration

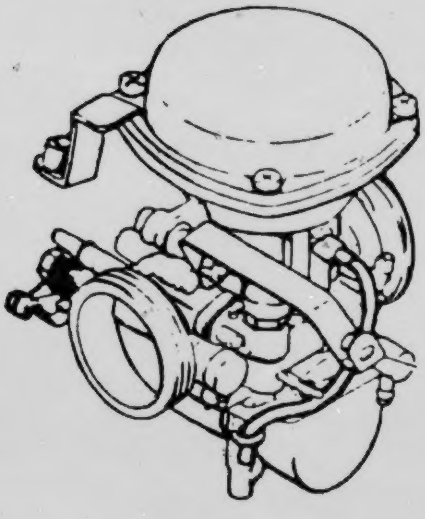
    (NOTE: Replacement with the incorrect type of main jet can result in incorrect fuel-air ratios.)

X. Differences in operation between types of slide valve carburetors
    A. Direct control
        1. Throttle cable connected directly to throttle slide valve
        2. Slide movement controlled mechanically by the rider
    B. Constant velocity
        1. Throttle cable connected to throttle valve shaft
        2. Slide movement controlled by vacuum diaphragm or piston

# SLIDE VALVE CARBURETOR TYPES

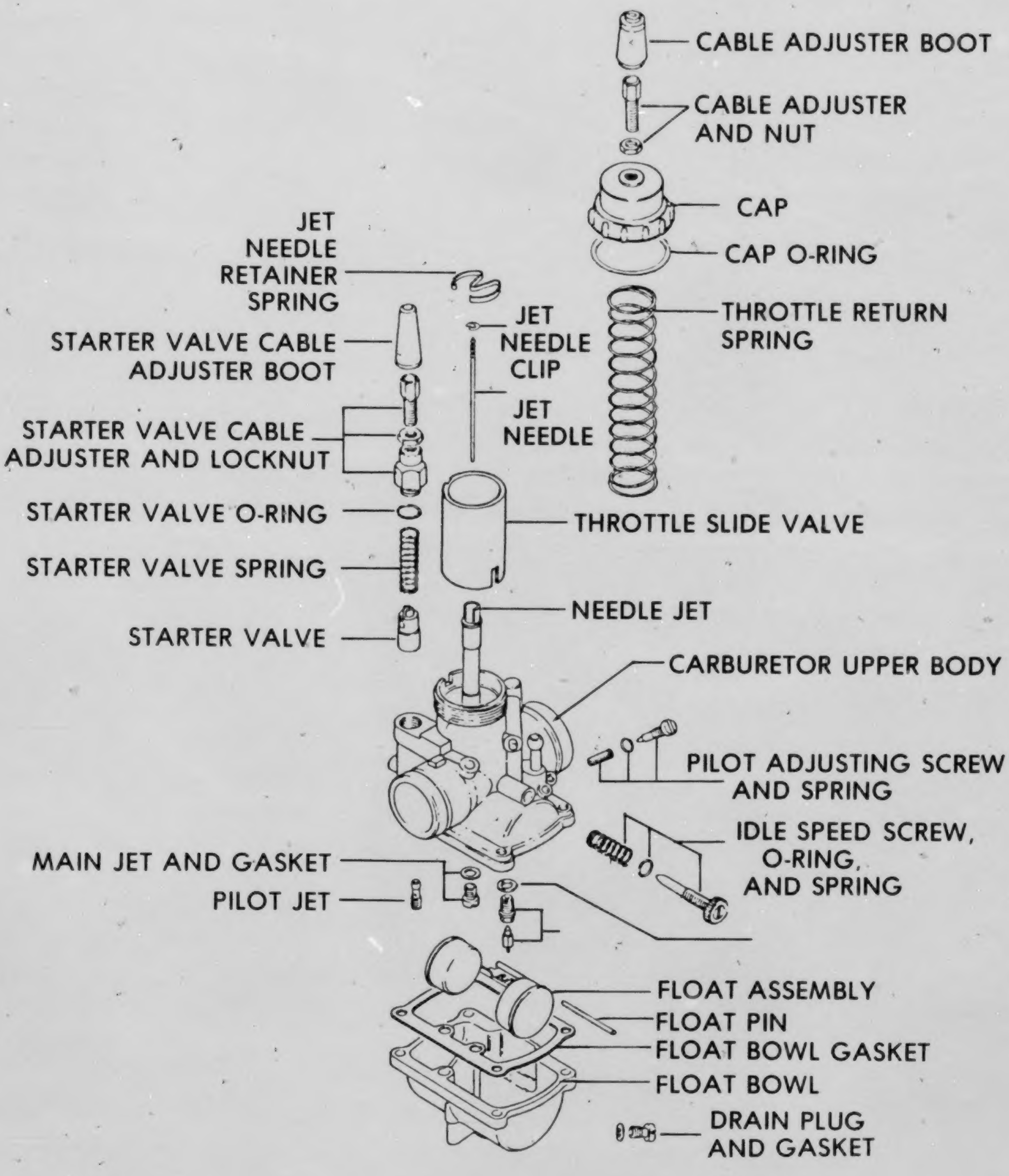


DIRECT CONTROL

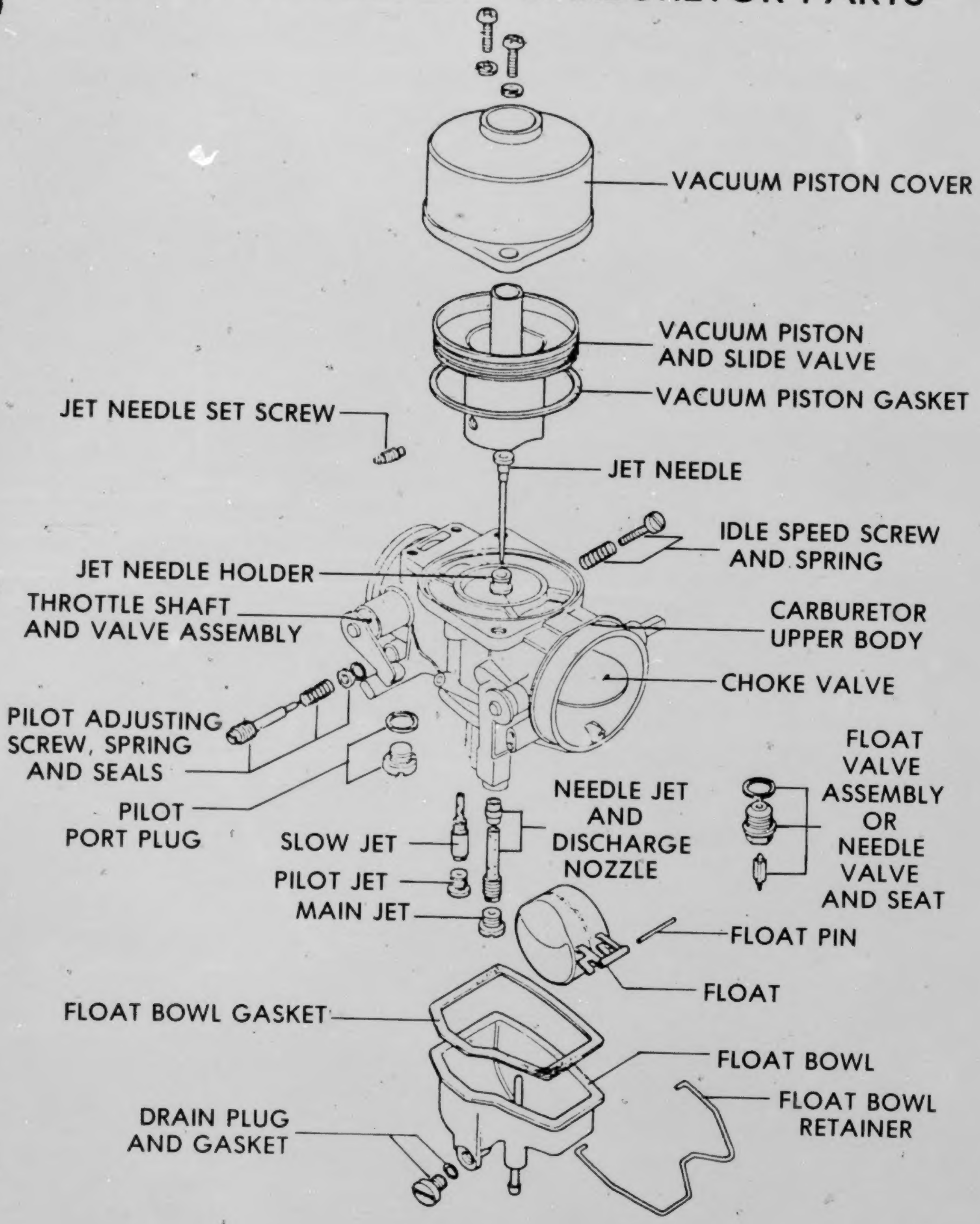


CONSTANT VELOCITY

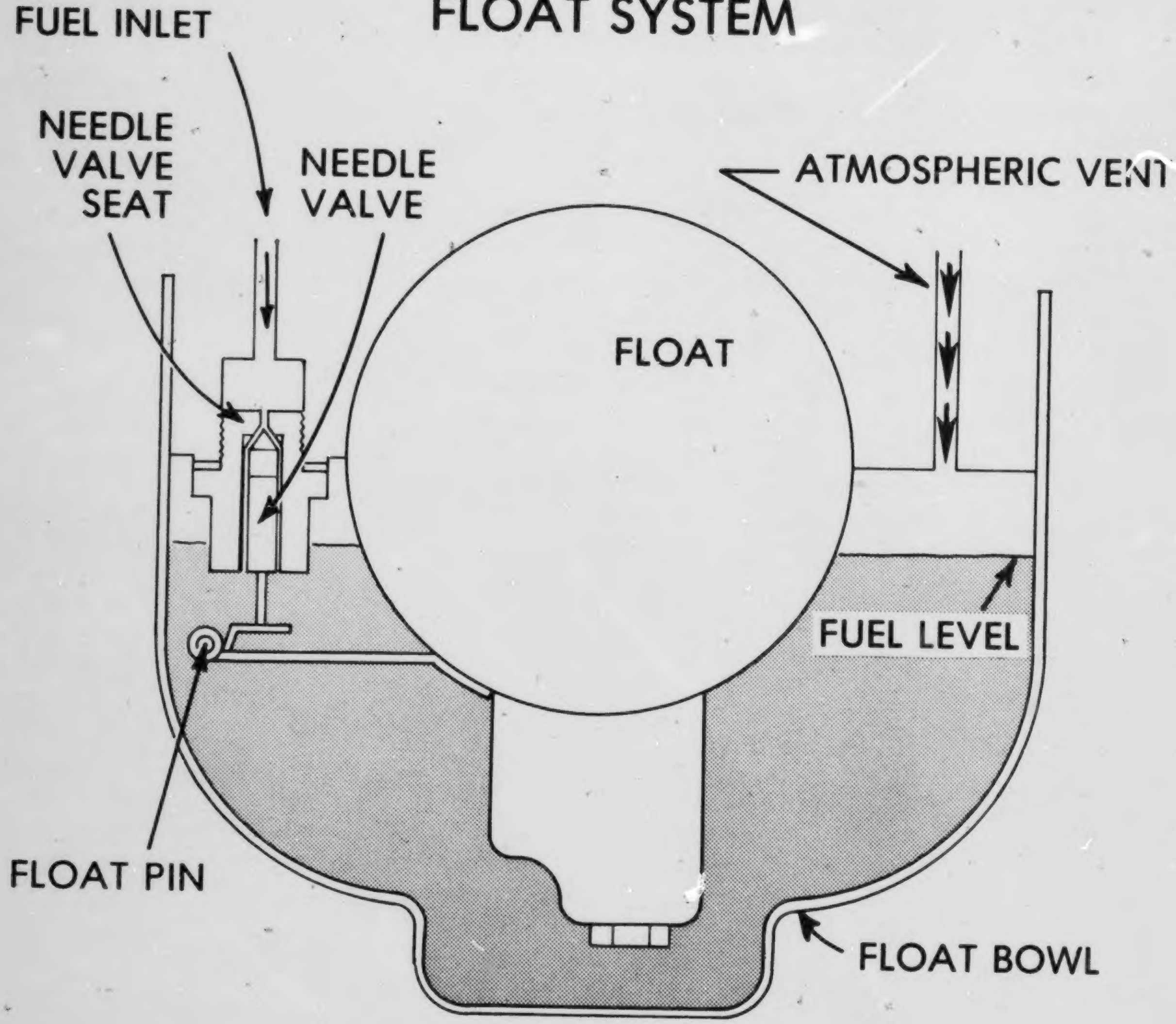
# DIRECT CONTROL CARBURETOR PARTS


CABLE ADJUSTER BOOT
CABLE ADJUSTER AND NUT
CAP
CAP O-RING
JET NEEDLE RETAINER SPRING
THROTTLE RETURN SPRING
STARTER VALVE CABLE ADJUSTER BOOT
JET NEEDLE CLIP
JET NEEDLE
STARTER VALVE CABLE ADJUSTER AND LOCKNUT
STARTER VALVE O-RING
THROTTLE SLIDE VALVE
STARTER VALVE SPRING
NEEDLE JET
STARTER VALVE
CARBURETOR UPPER BODY
PILOT ADJUSTING SCREW AND SPRING
IDLE SPEED SCREW, O-RING, AND SPRING
MAIN JET AND GASKET
PILOT JET
FLOAT ASSEMBLY
FLOAT PIN
FLOAT BOWL GASKET
FLOAT BOWL
DRAIN PLUG AND GASKET

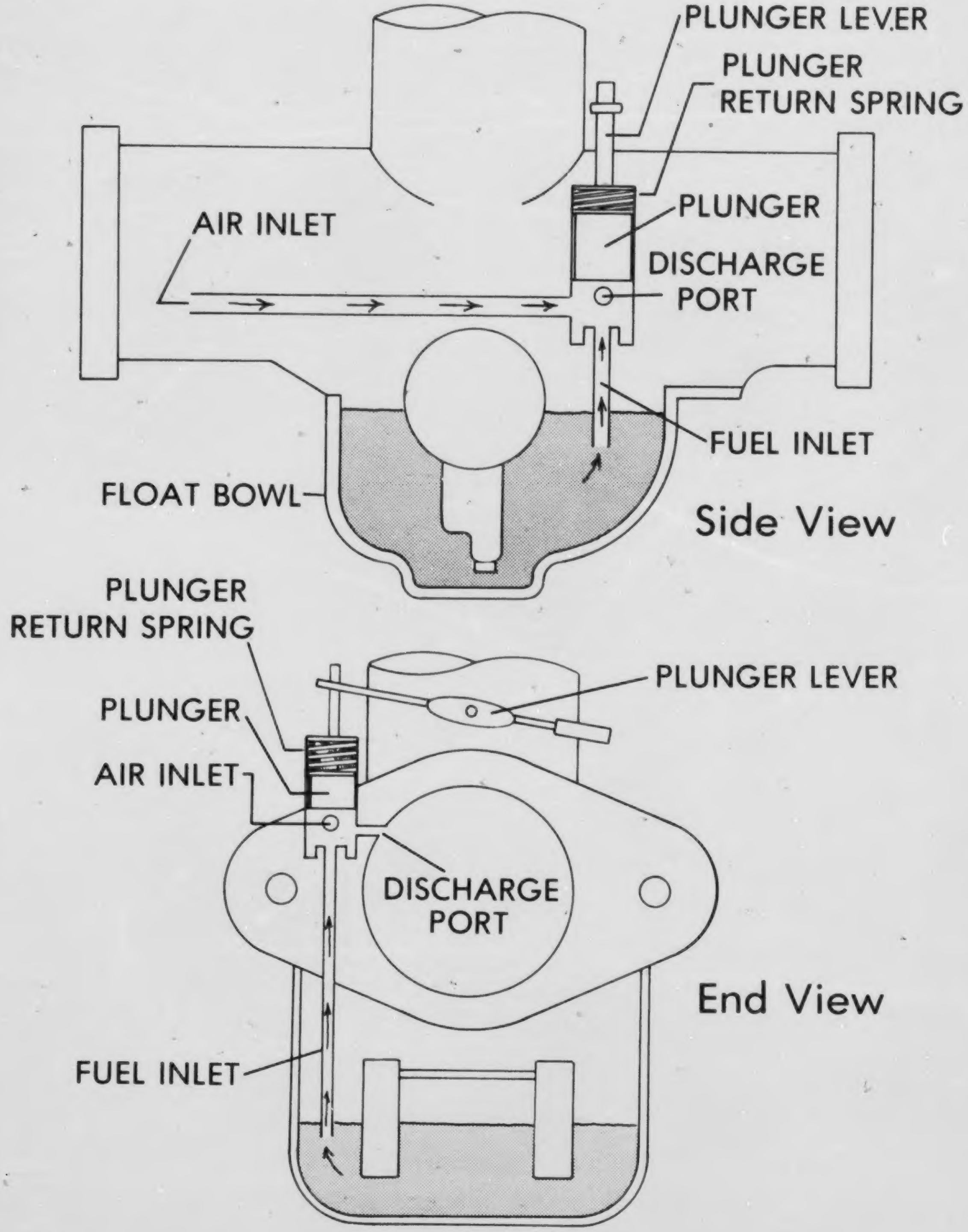
# CONSTANT VELOCITY CARBURETOR PARTS


VACUUM PISTON COVER
VACUUM PISTON AND SLIDE VALVE
VACUUM PISTON GASKET
JET NEEDLE SET SCREW
JET NEEDLE
IDLE SPEED SCREW AND SPRING
JET NEEDLE HOLDER
THROTTLE SHAFT AND VALVE ASSEMBLY
CARBURETOR UPPER BODY
CHOKE VALVE
PILOT ADJUSTING SCREW, SPRING AND SEALS
FLOAT VALVE ASSEMBLY OR NEEDLE VALVE AND SEAT
NEEDLE JET AND DISCHARGE NOZZLE
PILOT PORT PLUG
SLOW JET
PILOT JET
MAIN JET
FLOAT PIN
FLOAT
FLOAT BOWL GASKET
FLOAT BOWL
FLOAT BOWL RETAINER
DRAIN PLUG AND GASKET

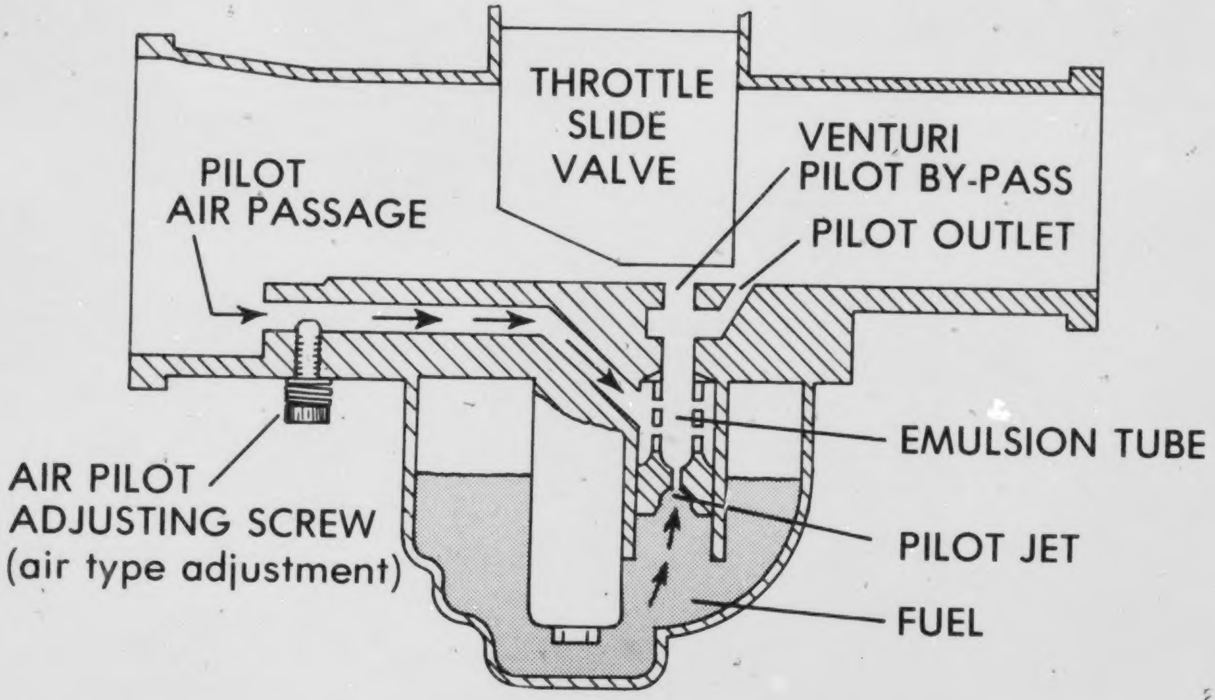
# FLOAT SYSTEM

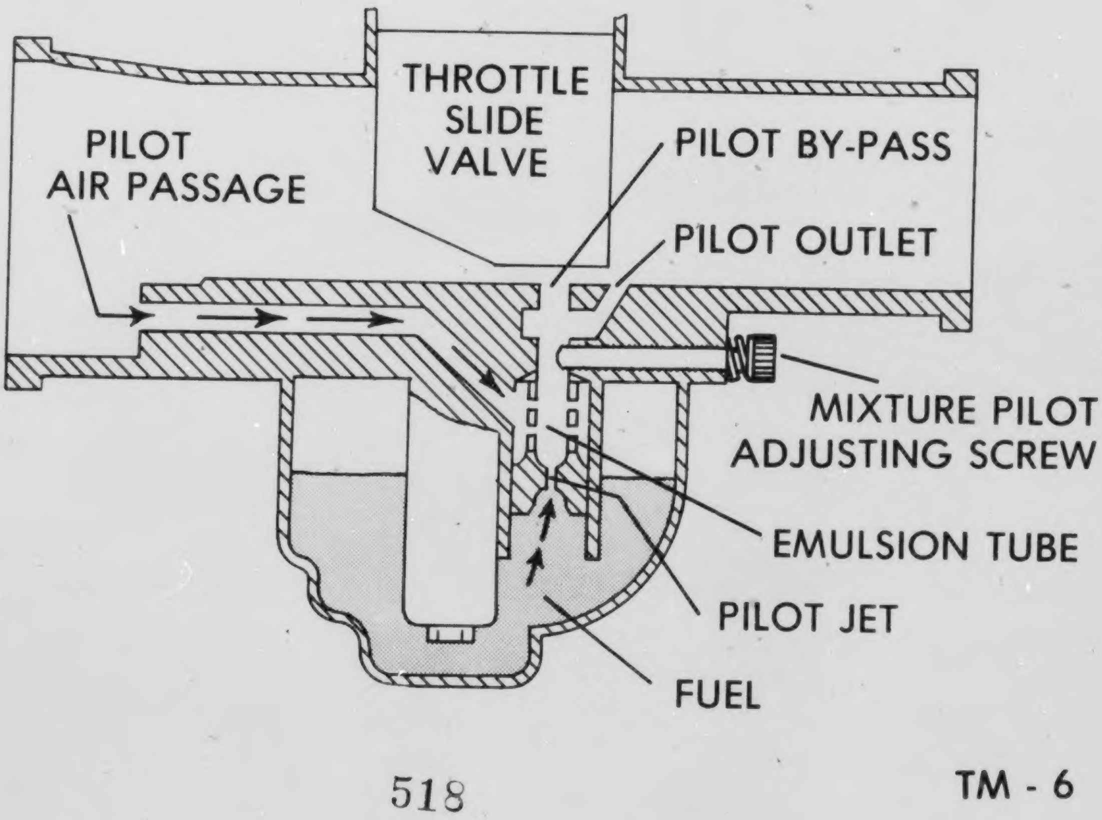

FUEL INLET
NEEDLE VALVE SEAT
NEEDLE VALVE
ATMOSPHERIC VENT
FLOAT
FUEL LEVEL
FLOAT PIN
FLOAT BOWL

# STARTER SYSTEM-LEVER OPERATED

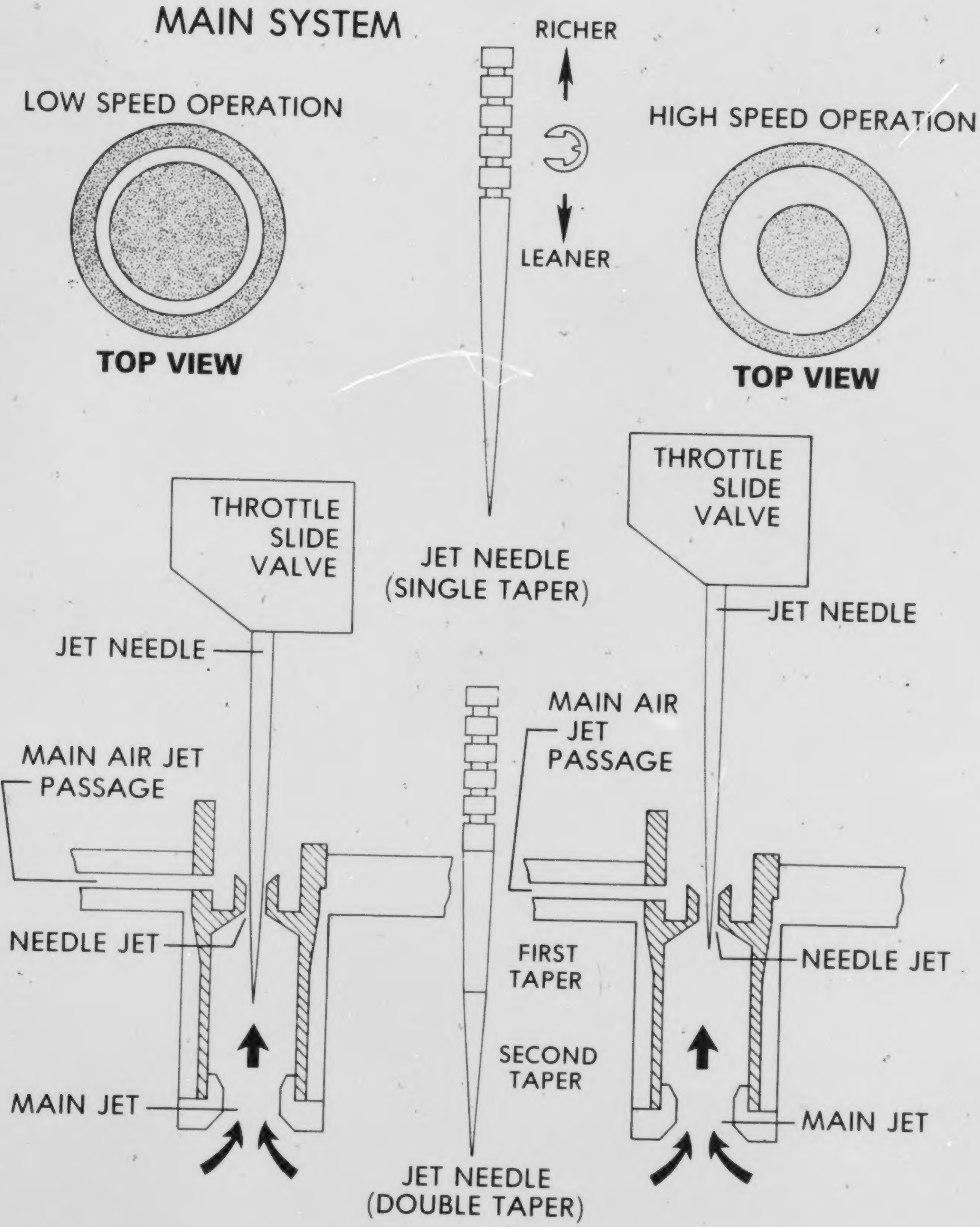

PLUNGER LEVER
PLUNGER RETURN SPRING
PLUNGER
AIR INLET
DISCHARGE PORT
FUEL INLET
FLOAT BOWL
Side View
PLUNGER RETURN SPRING
PLUNGER
AIR INLET
PLUNGER LEVER
DISCHARGE PORT
FUEL INLET
End View

# PILOT AND INTERMEDIATE SPEED SYSTEM


THROTTLE SLIDE VALVE
PILOT AIR PASSAGE
VENTURI PILOT BY-PASS
PILOT OUTLET
EMULSION TUBE
AIR PILOT ADJUSTING SCREW (air type adjustment)
PILOT JET
FUEL

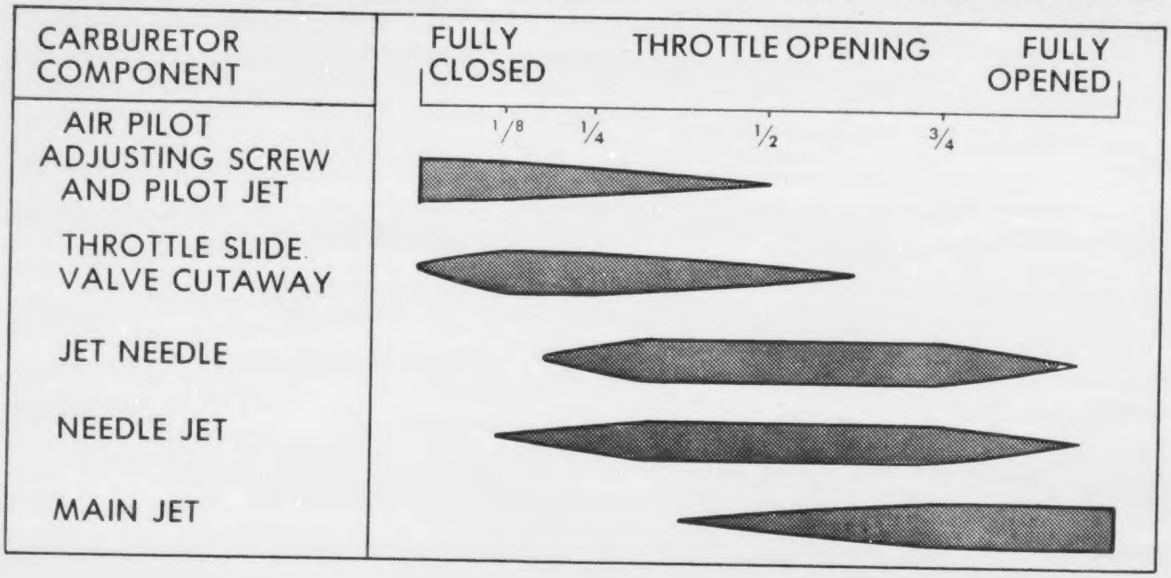

THROTTLE SLIDE VALVE
PILOT AIR PASSAGE
PILOT BY-PASS
PILOT OUTLET
MIXTURE PILOT ADJUSTING SCREW
EMULSION TUBE
PILOT JET
FUEL

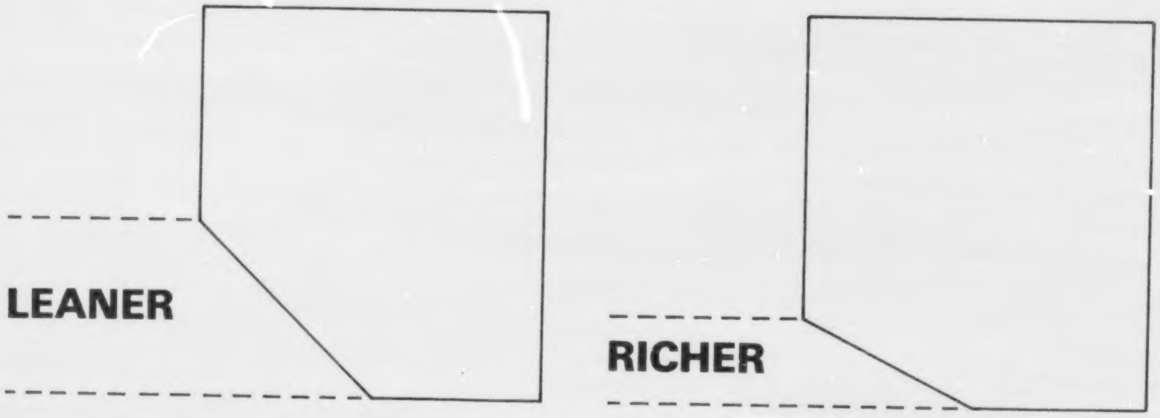
# MAIN SYSTEM


LOW SPEED OPERATION
TOP VIEW
RICHER
LEANER
JET NEEDLE (SINGLE TAPER)
HIGH SPEED OPERATION
TOP VIEW
THROTTLE SLIDE VALVE
JET NEEDLE
MAIN AIR JET PASSAGE
NEEDLE JET
MAIN JET
FIRST TAPER
SECOND TAPER
JET NEEDLE (DOUBLE TAPER)
THROTTLE SLIDE VALVE
JET NEEDLE
MAIN AIR JET PASSAGE
NEEDLE JET
MAIN JET

# MAIN SYSTEM-THROTTLE OPENING RELATIONSHIP

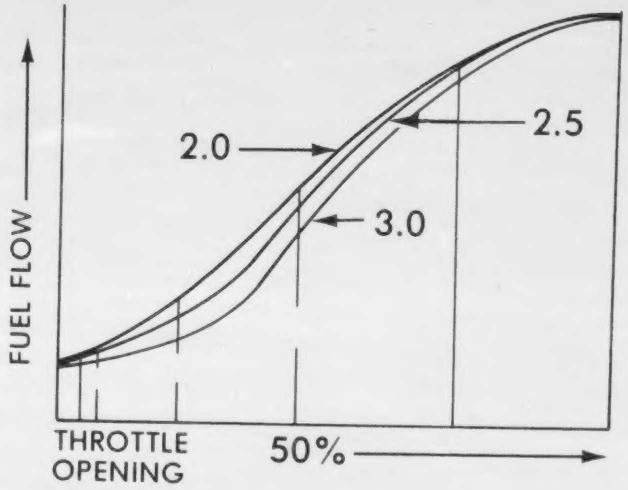
WORKING RANGE OF EACH CARBURETOR COMPONENT

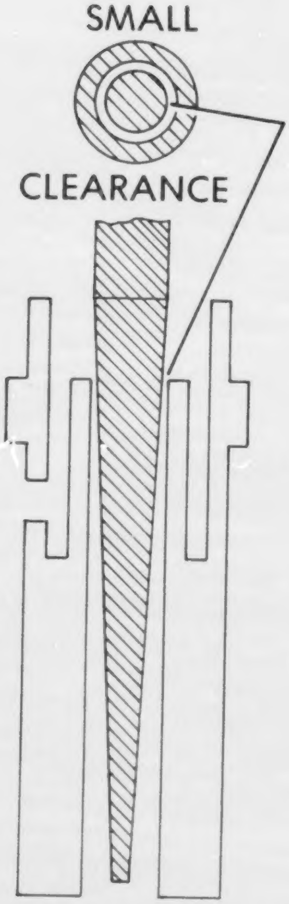


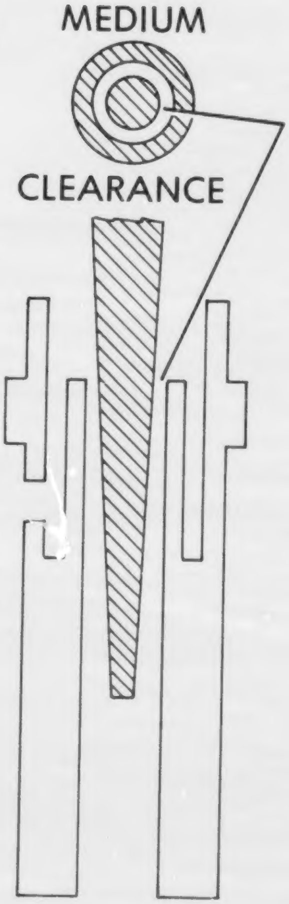


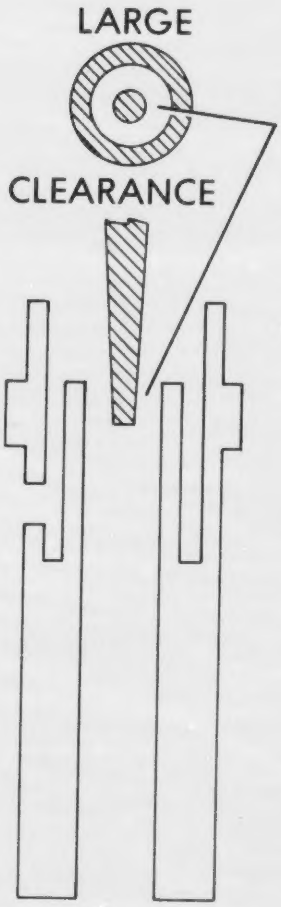
THROTTLE SLIDE VALVE CUTAWAY

# MAIN SYSTEM- FUEL FLOW AND JET NEEDLE CLEARANCE




SMALL
CLEARANCE


MEDIUM
CLEARANCE


LARGE
CLEARANCE

# SLIDE VALVE CARBURETORS
## UNIT I

## JOB SHEET #1--DISASSEMBLE, SERVICE, AND REASSEMBLE A SLIDE VALVE CARBURETOR

I. Tools and materials

   A. Direct control slide valve carburetor

   B. Hand tool assortment

   C. Metric combination wrenches

   D. Metric sockets

   E. Carburetor cleaning solvent

   F. Shop towels

   G. Compressed air

   H. Appropriate float level gauge, if required

   I. Appropriate service manual

   J. Safety glasses

II. Procedure

   A. Disassemble the carburetor

      1. Unscrew slide valve cap and remove the cap, cap o-ring, return spring, throttle slide valve, and jet needle assembly

      2. Remove jet needle retainer and jet needle from throttle slide valve

         (NOTE: Observe in which groove of the jet needle the needle clip is installed.)

      3. Lay all parts in an orderly manner on a clean shop towel

      4. Remove the float bowl screws and float bowl from the carburetor upper body

      5. Remove float pin and float

      6. Remove needle valve, seat, and gasket

      7. Remove main jet and needle jet from carburetor upper body

## JOB SHEET #1

8. Remove pilot jet, air or mixture pilot adjusting screw, and idle speed screw from upper body

9. Remove starter valve assembly from carburetor, if so equipped

B. Clean and service the carburetor

1. Wash all parts in clean solvent and dry with compressed air

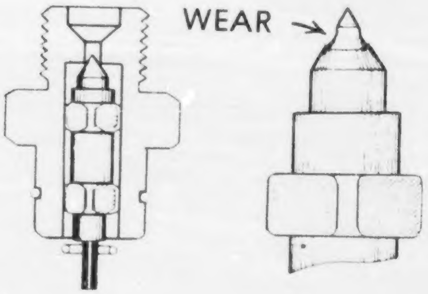
2. Blow compressed air through all jets and through fuel and air passageways in the carburetor body

   (NOTE: Place all cleaned parts on a clean shop towel.)

3. Inspect needle valve and seat for wear (Figure 1)

Needle Valve and Valve Seat

FIGURE 1



4. Inspect float pin for wear

5. Inspect the float for cracks, deformation, or signs of leakage

6. Inspect throttle slide valve carefully for rubbing or scoring

   (NOTE: A badly worn slide valve will allow air to leak past its sides, causing a lean mixture. A scored slide can stick in the carburetor upper body bore causing serious control problems. Make sure the slide moves freely with no binding.)

7. Check the jet needle for straightness and signs of wear

   (NOTE: If needle shows excessive wear, the jet is most likely also worn and should be replaced along with the needle. A worn needle and jet will allow too much fuel to enter the engine, resulting in too rich a mixture.)

## JOB SHEET #1

8. Check the main and pilot jets for stripped or cross threading

   (NOTE: Overtightening is the most common cause of damage.)

9. Inspect the air or mixture pilot adjusting screw for wear or damage on the screw taper

10. Check plunger for scoring and cracking or other damage to the seal on the bottom of the plunger

    (NOTE: On constant velocity carburetors, check vacuum piston for wear and scoring; diaphragm for cracks, pin holes, and flexibility.)

C. Reassemble the carburetor

1. Replace starter valve assembly

2. Replace all jets and tighten securely

3. Install float valve assembly and float

4. Check float height and adjust if necessary, following manufacturer's instructions (Figure 2)

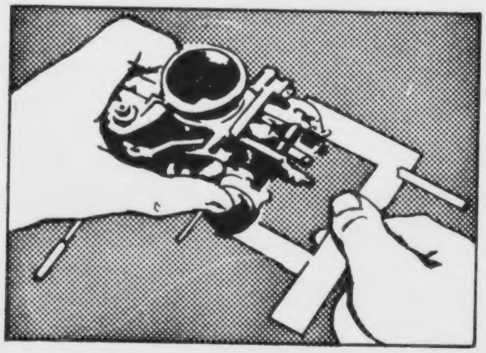


FIGURE 2

   (NOTE: Not all float measurement and adjusting procedures are the same. The illustrations with this job sheet are typical methods commonly used.)

5. Replace float bowl and gasket

6. Install jet needle in slide valve

   (NOTE: Be sure needle clip is in proper groove and retainer doesn't interfere with connecting the throttle cable.)

## JOB SHEET #1

7. Replace throttle slide valve and jet needle assembly in carburetor upper body

   (NOTE: Slide valves usually have a groove on one side. This groove must fit the lug inside the carburetor body. Remember, the slide valve cutaway must face the air intake side of the carburetor.)

8. Install throttle return spring, cap o-ring, and cap

9. Install air or mixture pilot adjusting screw and idle speed screw

   (NOTE: These screws have an initial adjustment; check the service manual. The final adjustments can only be made if the carburetor is put into service.)

# SLIDE VALVE CARBURETORS
# UNIT I

## JOB SHEET #2--ADJUST IDLE SPEED AND MIXTURE ON A SLIDE VALVE CARBURETOR

I. Tools and materials

A. Motorcycle in operating condition

B. Small screwdriver

C. Tachometer

D. Appropriate service manual

E. Safety glasses

II. Procedure

A. Connect tachometer to engine according to manufacturer's specifications

B. Start engine and allow it to warm up

C. Adjust idle speed screw to obtain the manufacturer's specified idle speed

D. Determine if pilot adjusting screw is an air type or a mixture type

E. Adjust mixture pilot adjusting screw

1. Turn the screw in slowly, to lean out mixture, until the engine begins to falter and RPM drops

2. Turn the screw out slowly until the engine smooths out and the RPM levels off

(NOTE: It may be necessary to readjust the idle speed screw for correct idle speed.)

F. Adjust air pilot adjusting screw

1. Turn screw in slowly, to enrich mixture, until the engine begins to falter and RPM drops

2. Turn the screw out slowly until the engine smooths out and the RPM levels off

(NOTE: It may be necessary to readjust the idle speed screw for correct idle speed.)

# SLIDE VALVE CARBURETORS
## UNIT I

## TEST

1. Match the terms on the right to the correct definitions.

_____a. Movable unit in the carburetor throat which controls amount of air which can enter the engine

_____b. Tapered shaft connected to throttle slide valve which controls amount of fuel which may be drawn into engine in relation to slide valve position

_____c. Narrowed section of the air passage of a carburetor which causes air speed to increase and air pressure to decrease

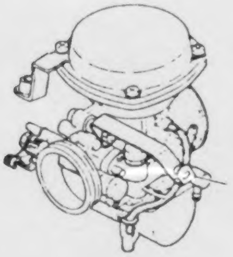
_____d. Main control valve for fuel entering the air stream

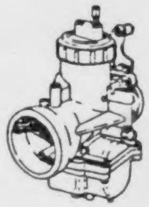
_____e. Perforated tube connected to pilot jet used to premix fuel and air

_____f. Jet through which fuel flows during low and idle speeds

1. Jet needle
2. Emulsion tube
3. Venturi
4. Needle jet
5. Variable venturi valve (throttle slide valve)
6. Pilot jet (idle or low speed jet)

2. Distinguish between direct control and constant velocity slide valve carburetors by placing an "X" next to the illustration of the constant velocity carburetor.





a. ______________________

b. ______________________

3. Match the location of the parts of a direct control carburetor on the right to the correct part names.

______a. Needle valve gasket

______b. Pilot jet

______c. Float bowl

______d. Starter valve spring

______e. Carburetor upper body

______f. Cable adjuster boot

______g. Jet needle

______h. Needle jet

______i. Needle valve and seat

______j. Float assembly

______k. Starter valve o-ring

______l. Idle speed screw, o-ring, and spring

______m. Drain plug and gasket

______n. Starter valve cable adjuster boot

______o. Main jet and gasket

______p. Throttle slide valve

______q. Cap

______r. Cable adjuster and nut

______s. Pilot adjusting screw and spring

______t. Jet needle retainer spring

______u. Cap o-ring

______v. Float pin

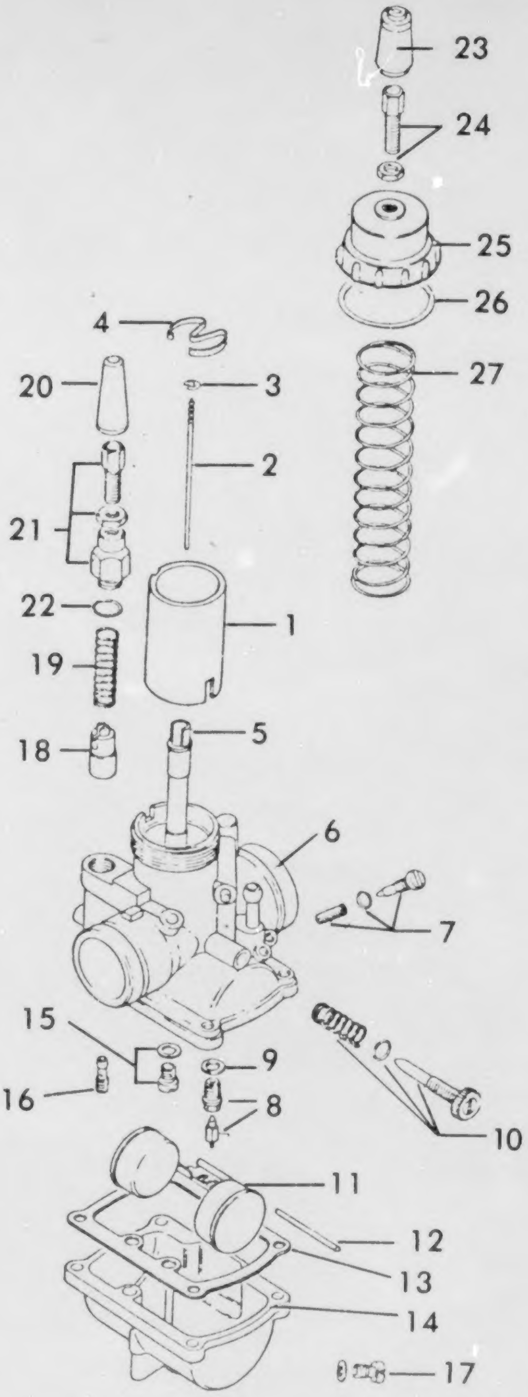
______w. Jet needle clip

______x. Starter valve

______y. Throttle return spring

______z. Float bowl gasket

____aa. Starter valve cable adjuster and locknut



4. Match the location of the parts of a constant velocity carburetor on the right to the correct part names.

_____a. Slow jet

_____b. Jet needle set screw

_____c. Vacuum piston gasket

_____d. Choke valve

_____e. Float

_____f. Drain plug and gasket

_____g. Pilot adjusting screw, spring, and seals

_____h. Carburetor upper body

_____i. Float bowl retainer

_____j. Vacuum piston cover

_____k. Pilot jet

_____l. Jet needle holder

_____m. Float valve assembly or needle valve and seat

_____n. Jet needle

_____o. Main jet

_____p. Pilot port plug

_____q. Float pin

_____r. Idle speed screw and spring

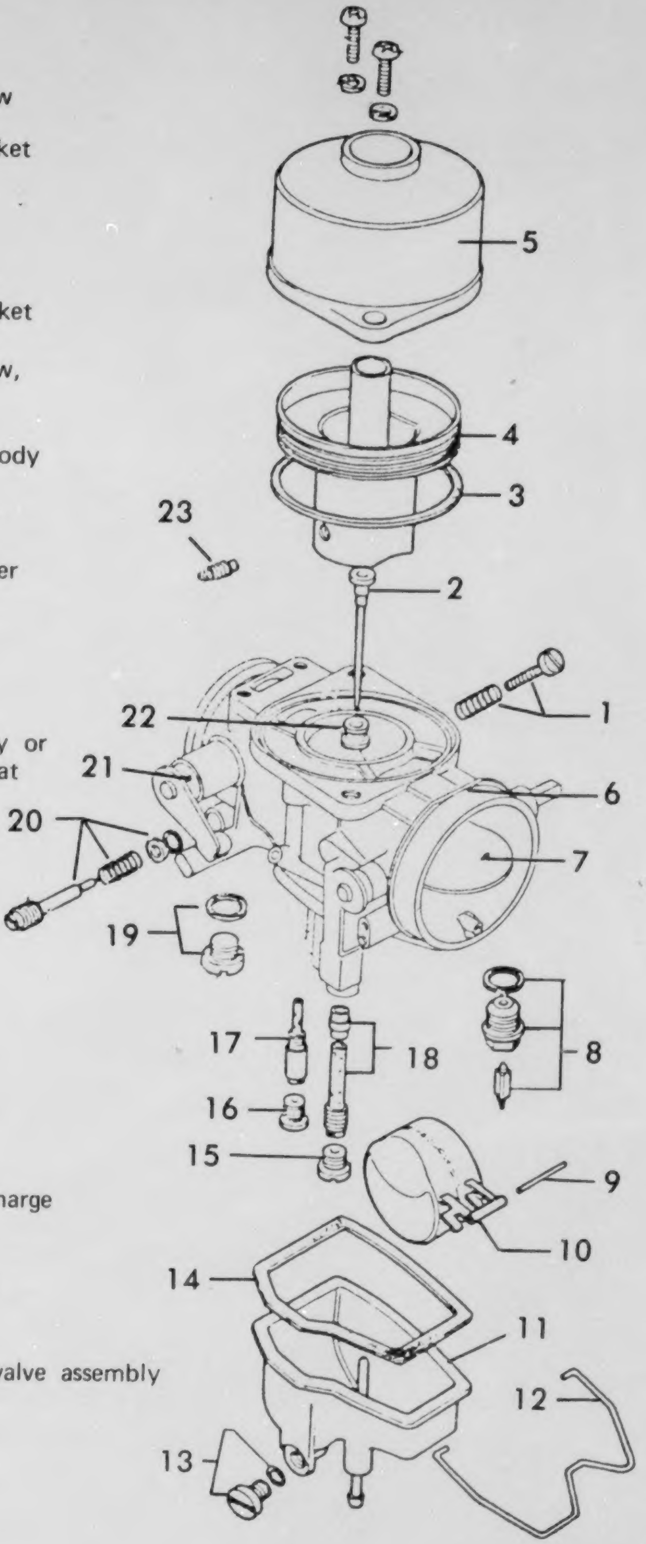
_____s. Float bowl

_____t. Needle jet and discharge nozzle

_____u. Vacuum piston and slide valve

_____v. Throttle shaft and valve assembly

_____w. Float bowl gasket



5. Select the systems of a slide valve carburetor by placing an "X" in the appropriate blanks.

_____a. Ignition system

_____b. Main system

_____c. Secondary system

_____d. Starter system

_____e. Pilot and intermediate speed system

_____f. Suspension system

_____g. Float system

6. Describe the operation of the float system.

7. Describe the operation of the starter system.

8. Describe the operation of the pilot and intermediate speed system.

9. Describe the operation of the main system.

10. Discuss the differences in operation between the two types of slide valve carburetors.

    a. Direct control

    b. Constant velocity

11. Demonstrate the ability to:

    a. Disassemble, service, and reassemble a slide valve carburetor.

    b. Adjust idle speed and mixture on a slide valve carburetor.

    (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

## SLIDE VALVE CARBURETORS
## UNIT I

## ANSWERS TO TEST

1. a. 5
b. 1
c. 3
d. 4
e. 2
f. 6

2. a

3. a. 9
b. 16
c. 14
d. 19
e. 6
f. 23
g. 2
h. 5
i. 8
j. 11
k. 22
l. 10
m. 17
n. 20
o. 15
p. 1
q. 25
r. 24
s. 7
t. 4
u. 26
v. 12
w. 3
x. 18
y. 27
z. 13
aa. 21

4. a. 17
b. 23
c. 3
d. 7
e. 10
f. 13
g. 20
h. 6
i. 12
j. 5
k. 16
l. 22
m. 8
n. 2
o. 15
p. 19
q. 9
r. 1
s. 11
t. 18
u. 4
v. 21
w. 14

5. b, d, e, g

6. Description should include:
   a. Maintains supply of fuel for all other metering systems of carburetor
   b. Fuel level controlled by the action of float and needle valve
      1) Fuel level in bowl drops
         a) Float drops slightly
         b) Needle moves away from seat
         c) Fuel enters bowl
      2) Fuel level in bowl rises
         a) Float rises
         b) Needle moves to contact seat
         c) Fuel flow to bowl shuts off
   c. Fuel level is kept constant by continual self-adjustment
7. Description should include:
   a. Provides extra rich fuel-air mixture for cold engine starts
   b. Rich mixture discharge controlled by plunger in air passage
      1) Plunger lifted off its seat
         a) High vacuum on engine side of closed slide valve pulls fuel from float bowl through pilot jet
         b) Fuel and air premixed in passage before entering carburetor throat
      2) Plunger returned to its seat shuts off flow of fuel and air in the starter system
8. Description should include:
   a. Meters fuel and air in the closed to 1/8 open throttle position
   b. Pilot system operates with throttle slide valve in the idle (fully closed) position
      1) Fuel is drawn through the pilot jet which protrudes into float chamber

2) Air enters through

a) Pilot air passage

b) Pilot by-pass

3) Air and fuel are premixed in the emulsion tube which is part of the pilot jet

4) Mixture is drawn out of pilot outlet to engine for idle operation

c. Intermediate system functions when throttle slide valve is raised off of seat

1) Larger volume of air passes through venturi

2) Pressure drops at opening of pilot by-pass

3) Pilot by-pass now discharges fuel along with pilot outlet

9. Description should include:

a. Meters fuel and air from 1/8 to full throttle position

b. Different components in control at different throttle positions

1) Throttle slide valve cutaway provides major control in the 1/8 to 1/4 throttle range

a) Higher cutaway-Leaner mixture

(1) Higher cutaway offers less resistance to incoming air

(2) Additional air flow with a constant fuel flow means a leaner mixture

b) Lower cutaway--Richer mixture

c) Cutaway size marked on bottom of throttle valve

d) Fuel flow change between cutaway sizes is greatest in the 25-50% throttle range

2) Jet needle and needle jet provide major control in the 1/4 to 3/4 throttle range

a) Jet needle rises up out of needle jet as throttle slide valve is raised

b) Tapered portion of needle arrives at upper end of jet at about 1/4 throttle

c) Throttle positions of 1/4 and above cause

(1) Clearance between needle and jet to gradually increase

(2) More fuel to flow through jet

d) Needle jet also preatomizes fuel

3) Main jet provides major control in the 3/4 to full throttle range

a) Main jet determines the total fuel flow when the clearance between needle jet and jet needle becomes greater than the area of main jet

b) Main jets available in three types, each with different numbering systems and standards for determining calibration

10. Discussion should include:

a. Direct control

1) Throttle cable connected directly to throttle slide valve

2) Slide movement controlled mechanically by the rider

b. Constant velocity

1) Throttle cable connected to throttle valve shaft

2) Slide movement controlled by vacuum diaphragm or piston

11. Performance skills evaluated to the satisfaction of the instructor

# 2-STROKE OIL INJECTION SYSTEMS
## UNIT I

## UNIT OBJECTIVE

After completion of this unit, the student should be able to identify the components of a 2-stroke oil injection system, discuss the different system designs, discuss oil injection pumps, and select advantages of this system. The student should also be able to service and adjust an oil injection system. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Select the advantages of an oil injection system.
2. Identify the components of the 2-stroke oil injection system.
3. Discuss the designs of oil injection systems.
4. Discuss oil injection pumps.
5. List the purposes of check valves.
6. Demonstrate the ability to:
    a. Check and adjust the injection pump control cable.
    b. Bleed an oil injection system.

## 2-STROKE OIL INJECTION SYSTEMS
## UNIT I

### SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss the procedures outlined in the job sheets.

  G. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Complete job sheets.

  D. Complete activities assigned by instructor.

  E. Take test.

### INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Components of Oil Injection System

    2. TM 2--Oil Injected into Intake Fuel-Air Mixture

    3. TM 3--Oil Pumped Directly into Crankshaft Bearings

4. TM 4--Crankcase Injection System
5. TM 5--Recycle Injection System
6. TM 6--Single Plunger Injection Pump
7. TM 7--Dual Plunger Injection Pump

D. Job sheets

1. Job Sheet #1--Check and Adjust the Injection Pump Control Cable
2. Job Sheet #2--Bleed an Oil Injection System

E. Test

F. Answers to test

II. References:

A. *Suzuki GT 550 Service Manual.* Suzuki Motor Co., Ltd., 1974.

B. *Honda MT 250 Service Manual.* Honda Motor Co., Ltd., 1975.

C. *Honda Motorcycle and Power Products Training Manual.* Gardena, California: American Honda Motor Co., Inc., 1975.

D. *Suzuki T-500 Service Manual.* Suzuki Motor Co., Ltd., 1969.

E. *Chilton's New Motorcycle Troubleshooting Guide.* Radnor, Pennsylvania: Chilton Book Co., 1973.

F. *Yamaha Supplemental Service Manual for 1974-MX Series and SC500A.* Yamaha Motor Co., Ltd.

# 2-STROKE OIL INJECTION SYSTEMS
## UNIT I

## INFORMATION SHEET

I. Advantages of oil injection system

   A. Premixing of oil with fuel is eliminated

   B. Pure oil is supplied directly to the engine, improving lubrication efficiency

   C. Amount of oil supplied is in accordance with engine needs

   D. Maintains a better balanced fuel-oil mixture

   E. Exhaust smoke is reduced

   F. Carbon accumulation is decreased

   G. Engine wear is decreased

   H. Economizes fuel consumption

II. Components of 2-stroke oil injection system (Transparency 1)

   A. Oil tank

   B. Inlet oil line

   C. Oil pump

   D. Outlet oil line

   E. Check valve

   F. Control cable

III. Designs of oil injection systems (Transparencies 2, 3, 4, and 5)

   A. Oil injected into intake fuel-air mixture

      1. Lubrication accomplished in same manner as premix

      2. Oil is metered according to engine speed and load

         Example: Yamaha "Autolube" and Kawasaki "Superlube"

## INFORMATION SHEET

B. Oil pumped directly into crankshaft bearings

   1. Oil passes through crankshaft to lubricate connecting rod needle bearings

   2. Excess oil which is thrown off by centrifugal force is mixed with fuel-air mixture in crankcase and drawn into combustion chamber

   Example: Early model Suzuki "Posi-Force" and Kawasaki "Injectolube"

C. Crankcase injection system

   1. Oil pumped to crankshaft bearings and injected directly onto cylinder walls

   2. Oil on cylinder walls provides excellent lubrication

   Example: Later model Suzuki "Posi-Force" and "CCI" system

D. Recycle injection system

   1. Excess oil from crankshaft bearings not mixed with fuel-air mixture

   2. One way valves in bottom of crankcase connected to transfer ports

   3. Oil is drawn into combustion chamber in small amounts, eliminating periods of excess smoke during acceleration

   Example: Suzuki recycle injection system

IV. Oil injection pumps (Transparencies 6 and 7)

A. Pumps are the heart of an injection system

B. Pumps have common operating principle

   1. Takes in oil

   2. Traps oil

   3. Pressurizes oil

   4. Discharges oil to lubricate engine

## INFORMATION SHEET

C. Pumps are of various designs

   1. Single plunger

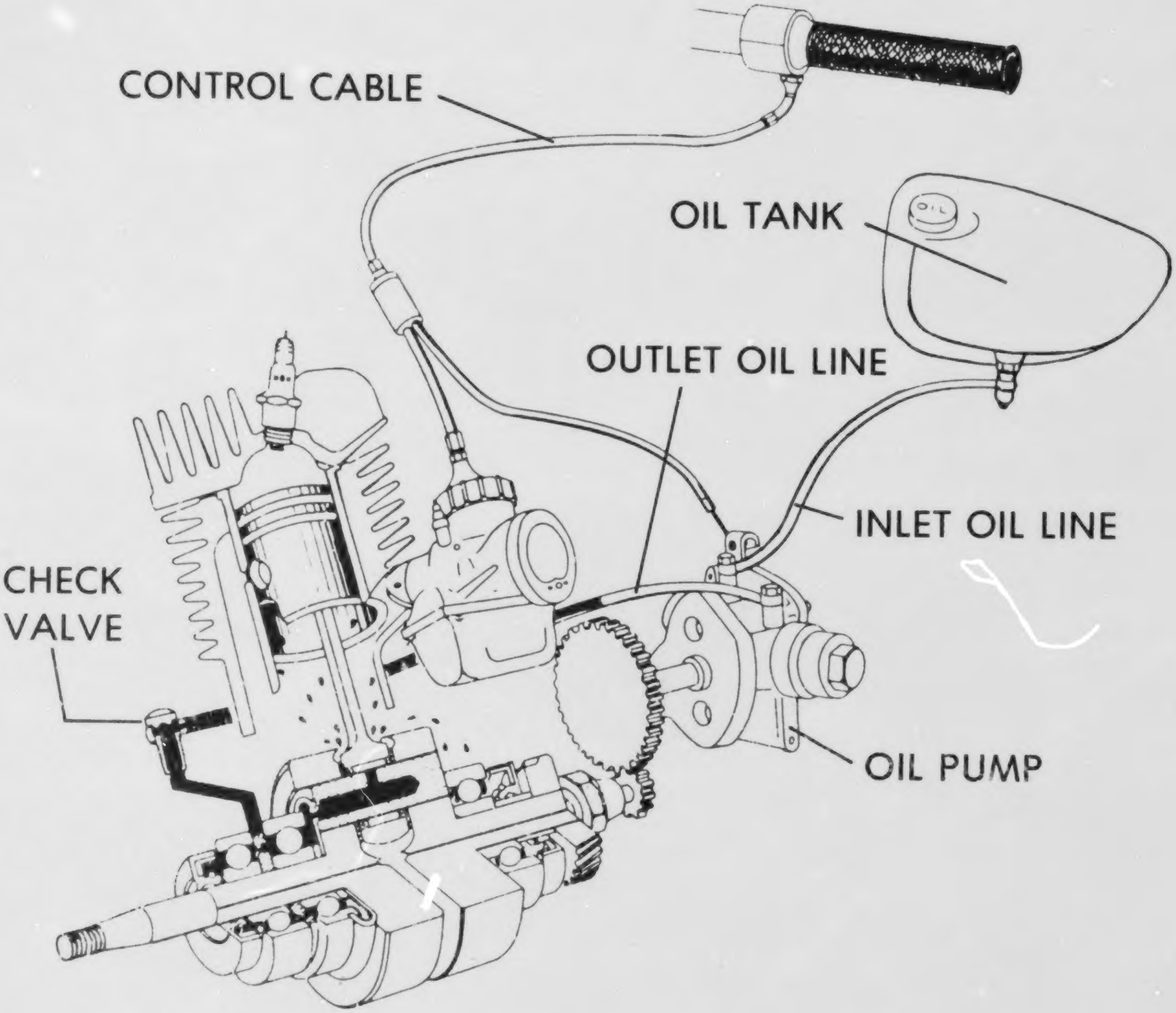
   2. Dual plunger

V. Purposes of check valves

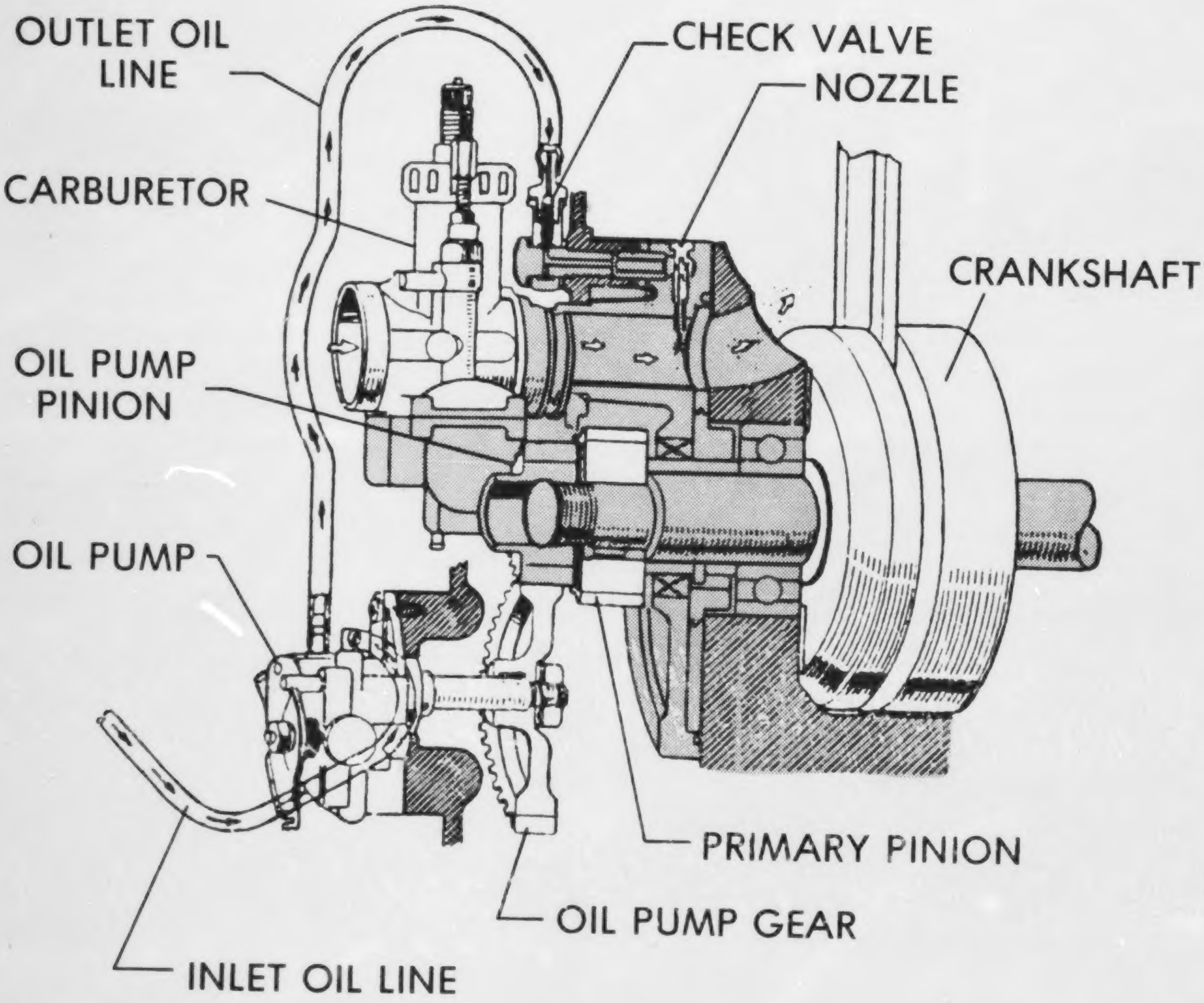
A. Maintain constant oil pressure

B. Seal lines to prevent air from entering system

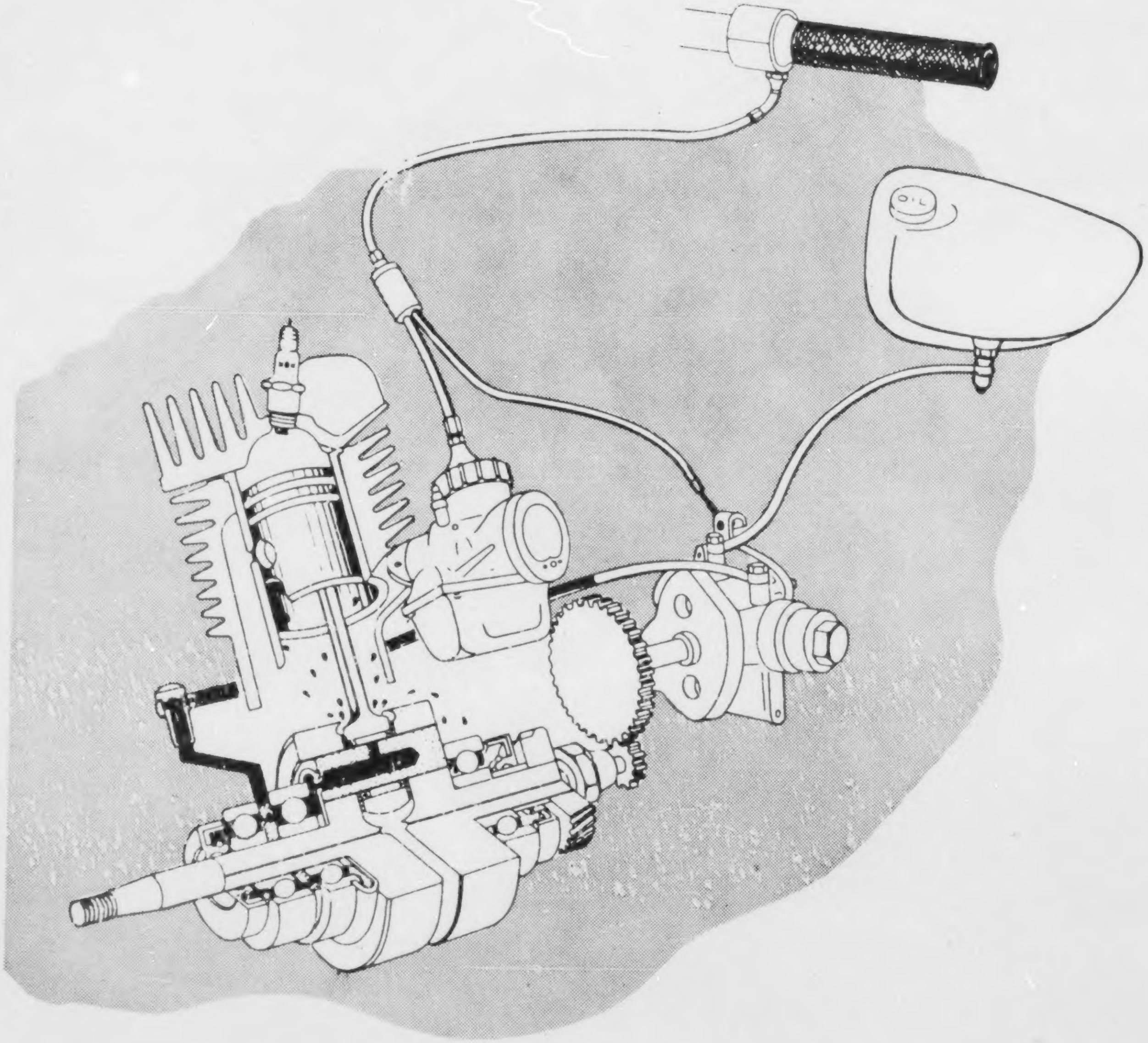
# COMPONENTS OF OIL INJECTION SYSTEM


CONTROL CABLE
OIL TANK
OUTLET OIL LINE
INLET OIL LINE
CHECK VALVE
OIL PUMP

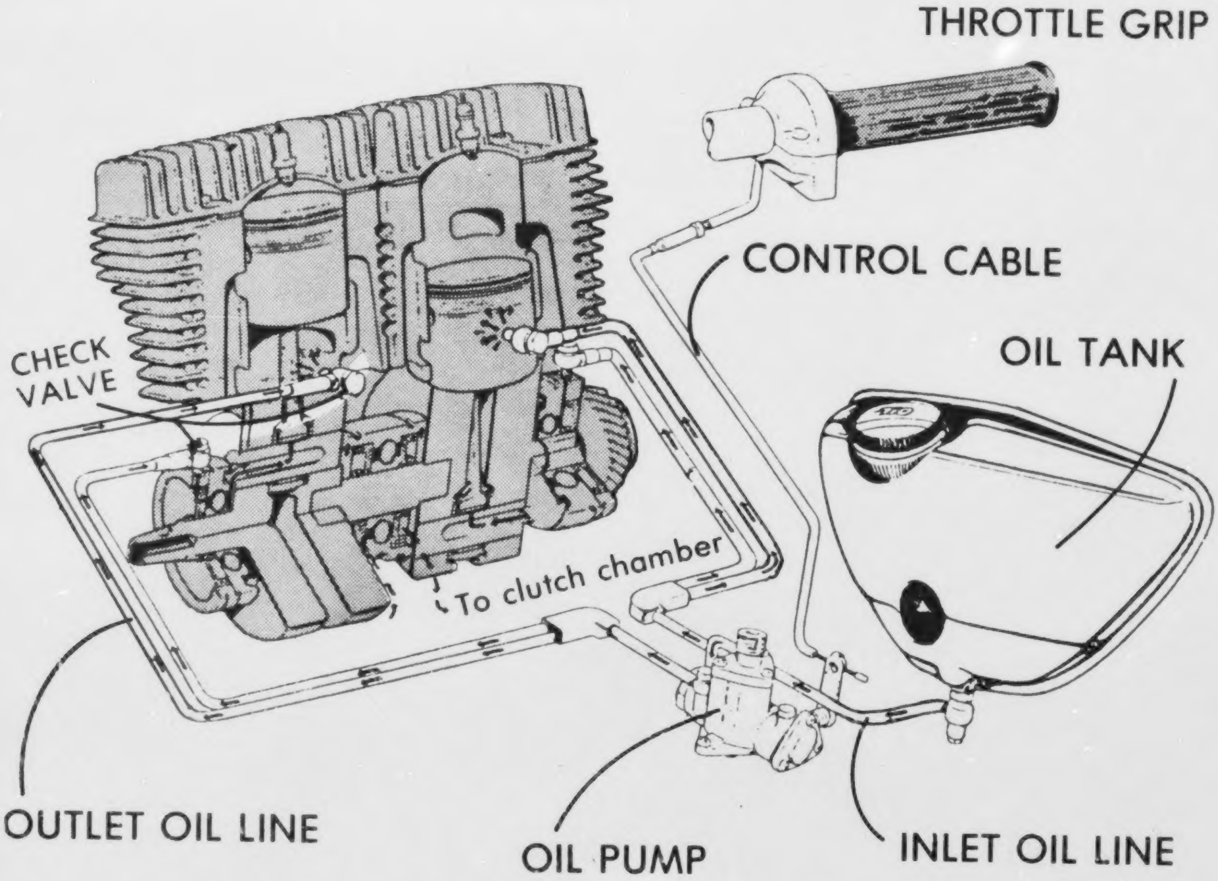
# OIL INJECTED INTO FUEL - AIR MIXTURE


OUTLET OIL LINE
CHECK VALVE
NOZZLE
CARBURETOR
CRANKSHAFT
OIL PUMP PINION
OIL PUMP
PRIMARY PINION
OIL PUMP GEAR
INLET OIL LINE

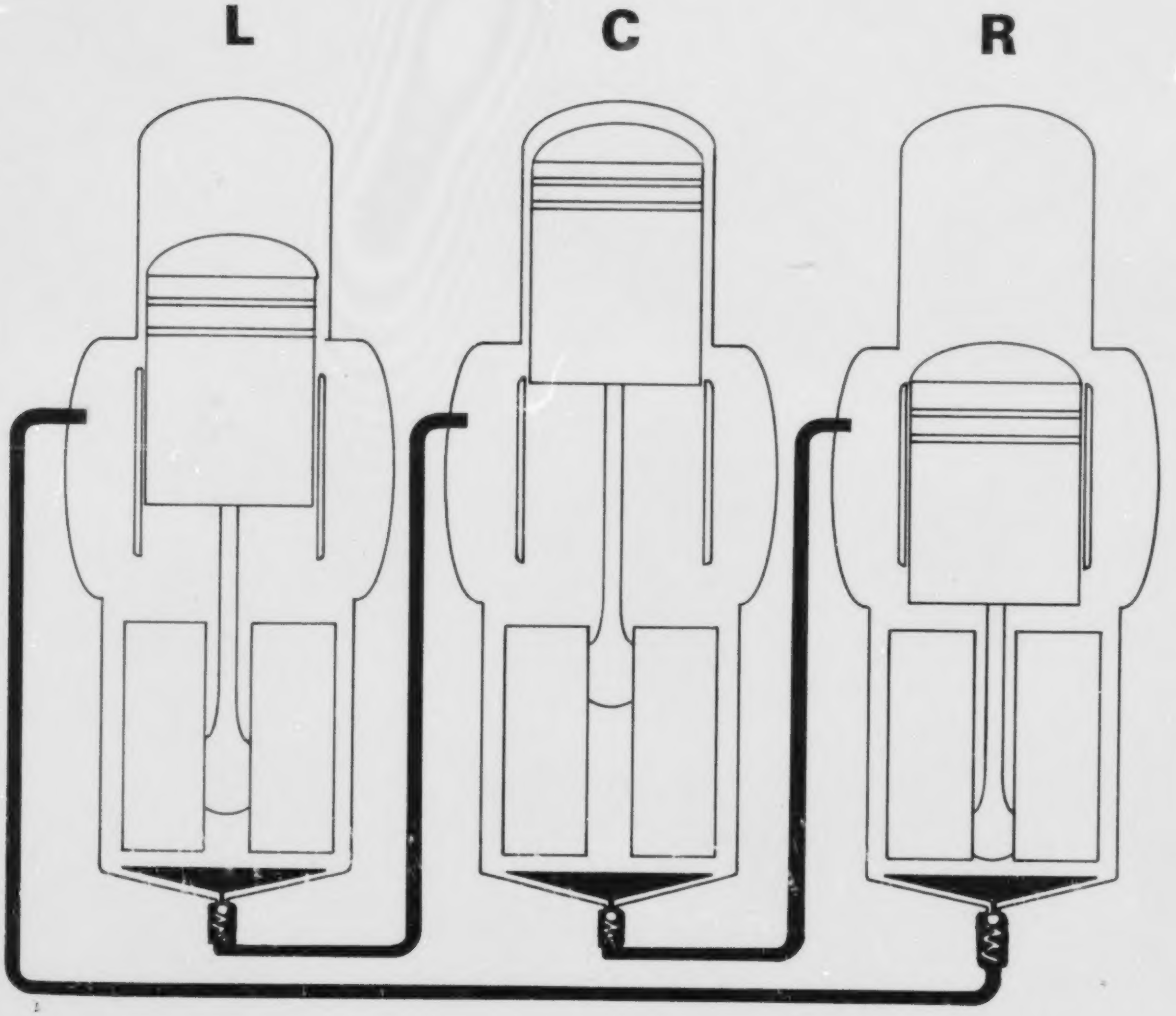
# OIL PUMPED DIRECTLY TO CRANKSHAFT BEARINGS



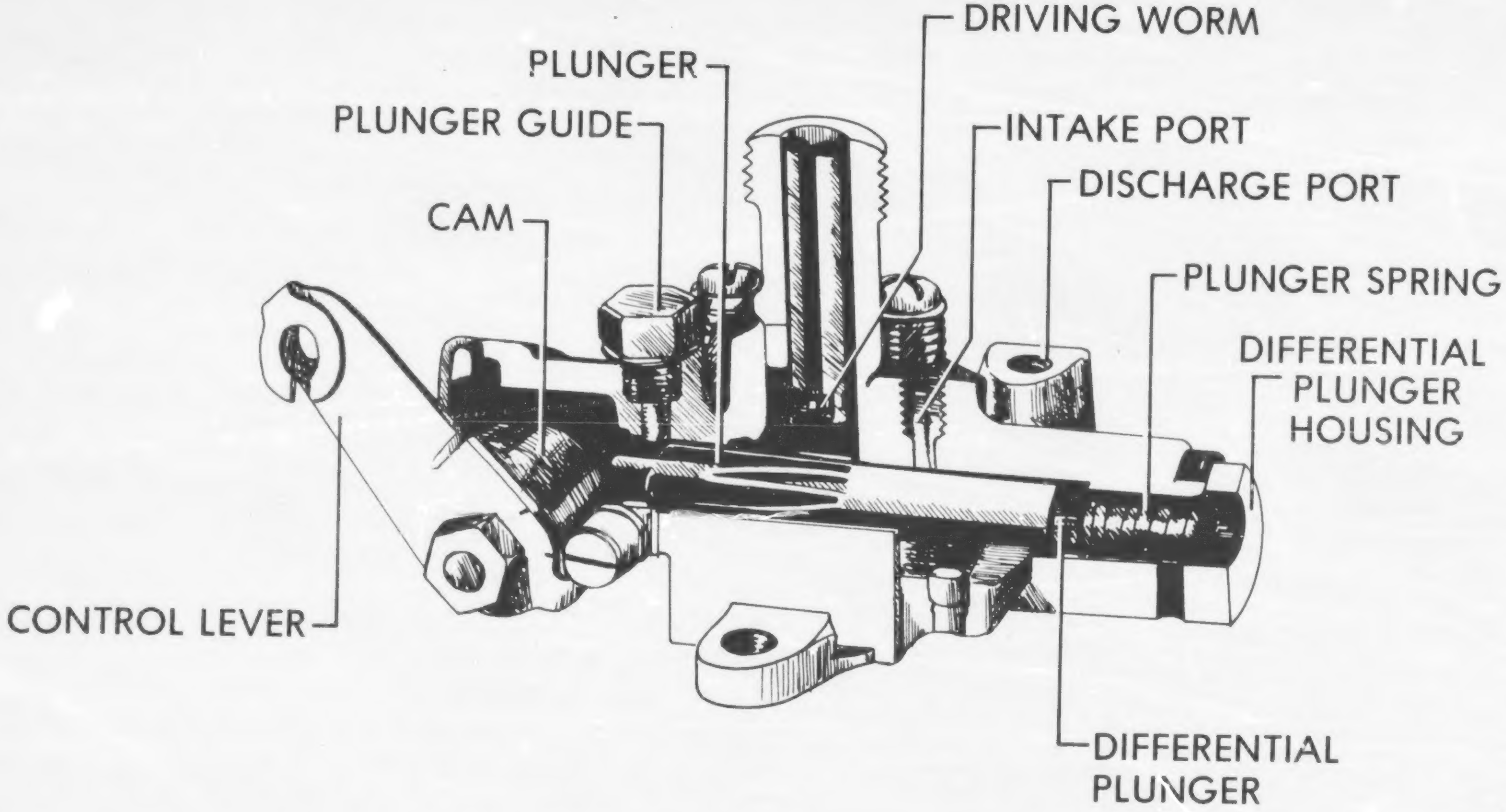
# CRANKCASE INJECTION SYSTEM


THROTTLE GRIP
CONTROL CABLE
OIL TANK
CHECK VALVE
To clutch chamber
OUTLET OIL LINE
OIL PUMP
INLET OIL LINE

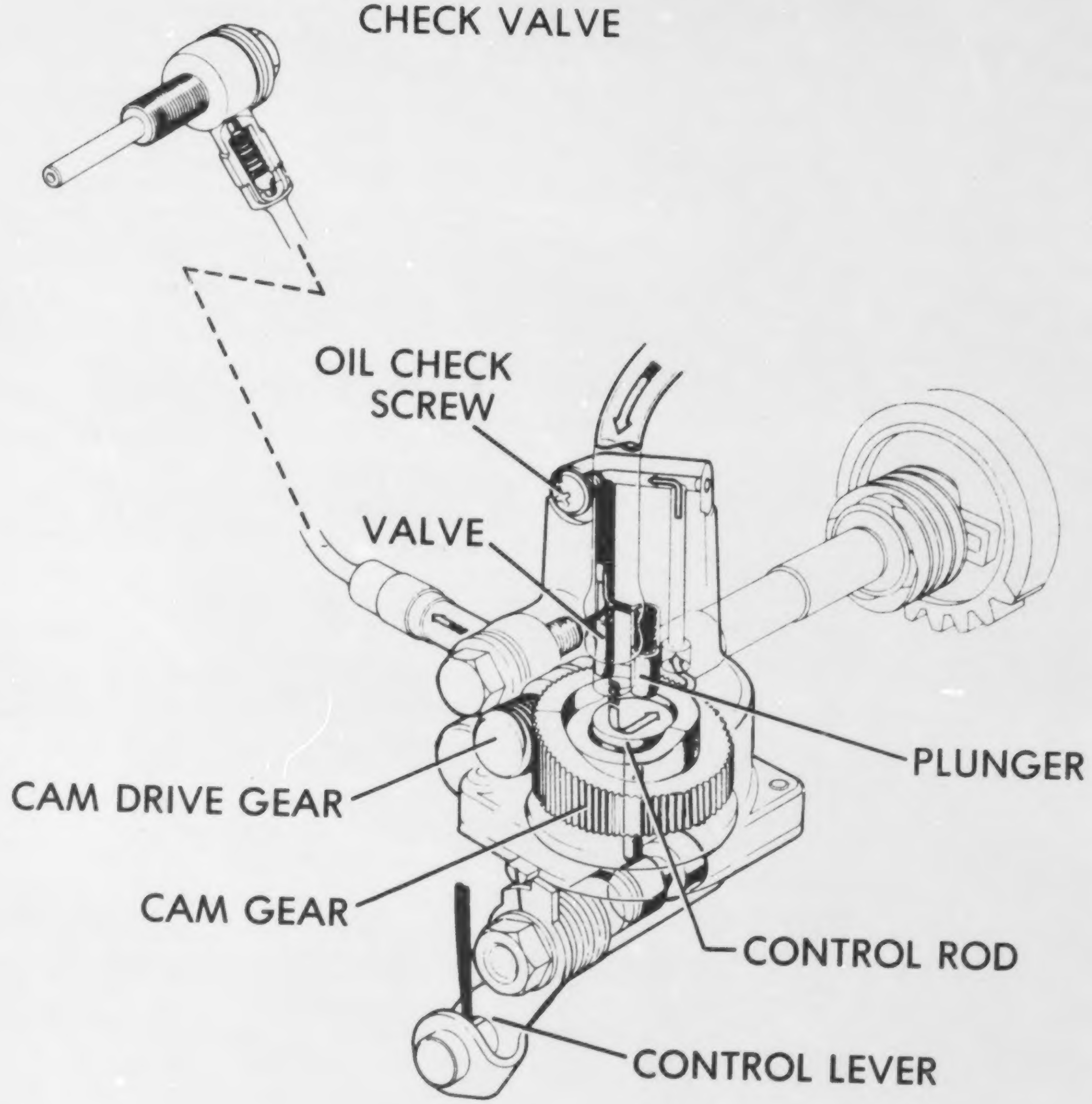
# RECYCLE INJECTION SYSTEM



# SINGLE PLUNGER INJECTION PUMP


DRIVING WORM
PLUNGER
PLUNGER GUIDE
INTAKE PORT
DISCHARGE PORT
CAM
PLUNGER SPRING
DIFFERENTIAL PLUNGER HOUSING
CONTROL LEVER
DIFFERENTIAL PLUNGER

# DUAL PLUNGER INJECTION PUMP


CHECK VALVE
OIL CHECK SCREW
VALVE
PLUNGER
CAM DRIVE GEAR
CAM GEAR
CONTROL ROD
CONTROL LEVER

## 2-STROKE OIL INJECTION SYSTEMS
## UNIT I

### JOB SHEET #1-CHECK AND ADJUST THE INJECTION PUMP CONTROL CABLE

I. Tools and materials

A. Motorcycle equipped with oil injection system

B. Set of small open end metric wrenches

C. Hand tool assortment

D. Impact driver

E. Appropriate service manual

F. Safety glasses

II. Procedure

(NOTE: Follow the specific service manual procedures for your vehicle make.)

A. Loosen oil pump case cover screws using impact driver

B. Remove oil pump case cover screws using screwdriver; lift off case cover

C. Fully close the throttle grip

D. Loosen the cable adjusting screw and locknut

E. Identify the pump alignment marks

F. Turn the cable adjusting screw in either direction until the pump alignment marks are aligned

(NOTE: Some pumps have a pin instead of one of the alignment marks.)

G. Operate the throttle grip several times to make sure the alignment marks don't change

(NOTE: If the marks don't stay in alignment, check the cable for binding and free it up if necessary.)

H. Retighten the adjusting screw and locknut

I. Replace oil pump case cover and tighten screws with impact driver

# 2-STROKE OIL INJECTION SYSTEMS
# UNIT I

## JOB SHEET #2-BLEED AN OIL INJECTION SYSTEM

I. Tools and materials

  A. Motorcycle equipped with oil injection system

  B. Set of small metric wrenches

  C. Impact driver

  D. Hand tool assortment

  E. Appropriate service manual

  F. Appropriate oil

  G. Safety glasses

II. Procedure

(NOTE: Some pumps are equipped with a special bleeder screw, while on other systems the banjo line connections must be loosened to expell the air.)

  A. Remove the pump cover using the impact driver, if necessary

  B. Bleed the oil inlet line by loosening the bleeder screw or the inlet line at its connection on the pump

  C. Allow the oil to flow out of the bleeder hole or the line until all air bubbles stop

  (NOTE: On some motorcycles with bleeder screws it may be necessary to hold the pump open by hand and turn the pump plunger by cranking the engine.)

  D. Retighten bleeder screw or line connection

  E. Bleed the outlet lines by loosening the connections at the engine

  F. Crank engine and run for a short period of time until all air is expelled

  (NOTE: Run engine at low RPM only.)

  G. Retighten all line connections and refill oil tank, if necessary

  H. Reinstall oil pump case cover and tighten screws with impact driver

# 2-STROKE OIL INJECTION SYSTEMS
## UNIT I

## TEST

1. Select the advantages of an oil injection system by placing an "X" in the appropriate blanks.

_____a. Exhaust smoke is greatly increased

_____b. Economizes fuel consumption

_____c. Higher top speed

_____d. Engine wear is decreased

_____e. Carbon accumulation is decreased

_____f. Exhaust smoke is reduced

_____g. Premixing of oil with fuel is required

_____h. Maintains a better balanced fuel-oil mixture

_____i. Increases spark plug life

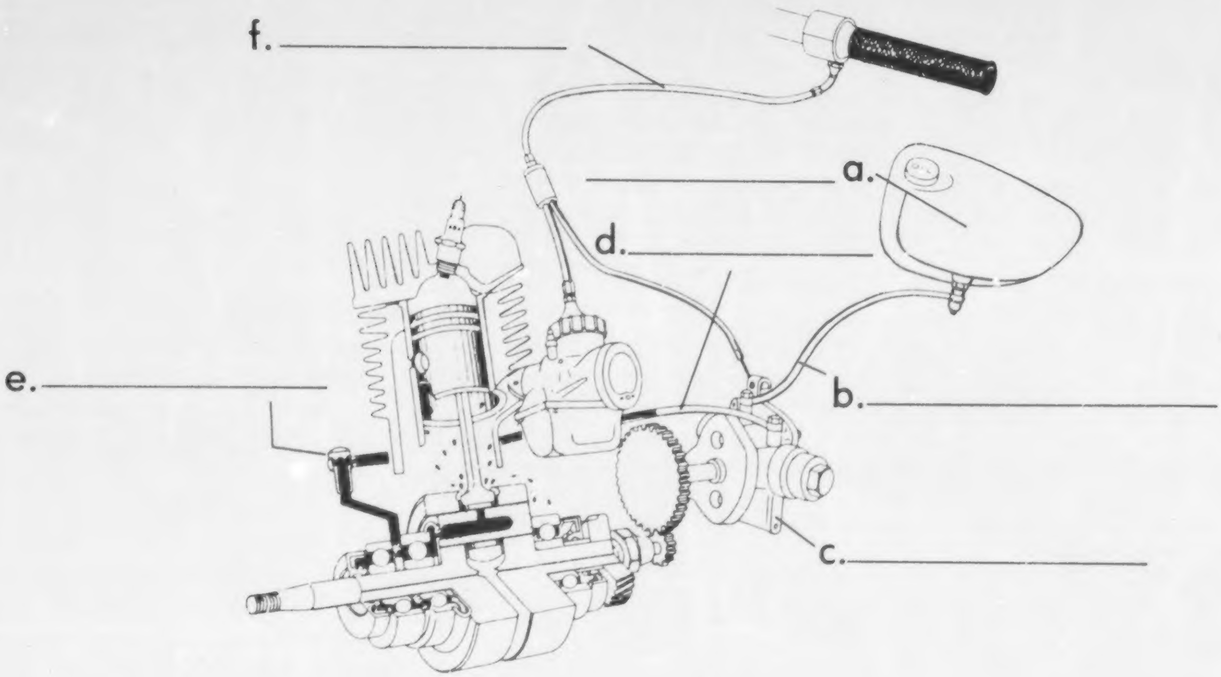
_____j. Amount of oil supplied is in accordance with engine needs

_____k. Easier starting

_____l. Pure oil is supplied directly to the engine, improving lubrication efficiency

_____m. Premixing of oil with fuel is eliminated

2. Identify the components of the 2-stroke oil injection system.



3. Discuss the designs of oil injection systems.

4. Discuss oil injection pumps.

5. List the purposes of check valves.

   a.

   b.

6. Demonstrate the ability to:

   a. Check and adjust the injection pump control cable.

   b. Bleed an oil injection system.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

# 2-STROKE OIL INJECTION SYSTEMS
## UNIT I

## ANSWERS TO TEST

1. b, d, e, f, h, j, l, m
2. a. Oil tank
   b. Inlet oil line
   c. Oil pump
   d. Outlet oil line
   e. Check valve
   f. Control cable
3. Discussion should include:
   a. Oil injected into intake fuel-air mixture
      1) Lubrication accomplished in same manner as premix
      2) Oil is metered according to engine speed and load
   b. Oil pumped directly into crankshaft bearings
      1) Oil passes through crankshaft to lubricate connecting rod needle bearings
      2) Excess oil which is thrown off by centrifugal force is mixed with fuel-air mixture in crankcase and drawn into combustion chamber
   c. Crankcase injection system
      1) Oil pumped to crankshaft bearings and injected directly onto cylinder walls
      2) Oil on cylinder walls provides excellent lubrication
   d. Recycle injection system
      1) Excess oil from crankshaft bearings are mixed with fuel-air mixture
      2) One way valves in bottom of crankcase connected to transfer ports
      3) Oil is drawn into combustion chamber in small amounts, eliminating periods of excess smoke during acceleration

4. Discussion should include:
    - a. Pumps are the heart of an injection system
    - b. Pumps have common operating principle
        - 1) Takes in oil
        - 2) Traps oil
        - 3) Pressurizes oil
        - 4) Discharges oil to lubricate engine
    - c. Pumps are of various designs
        - 1) Single plunger
        - 2) Dual plunger

5. a. Maintain constant oil pressure
    - b. Seal lines to prevent air from entering system

6. Performance skills evaluated to the satisfaction of the instructor

# OVERHEAD CAMSHAFTS
## UNIT I

## UNIT OBJECTIVE

After completion of this unit, the student should be able to define the terms associated with overhead camshafts and identify the major components of this system. The student should also be able to discuss its operation and demonstrate the ability to remove, inspect, and install an overhead camshaft and adjust the tensioning device. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

## SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define terms associated with overhead camshafts.
2. Identify the major components of the overhead camshaft system.
3. Select the types of overhead camshaft drives.
4. Identify the types of tensioners.
5. Discuss the operation of the overhead camshaft system.
6. Demonstrate the ability to:
    a. Remove, inspect, and reinstall an overhead camshaft.
    b. Adjust a tensioning device.

# OVERHEAD CAMSHAFTS
## UNIT I

## SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information sheet.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss the procedures outlined in the job sheets.

   G. Obtain damaged parts for demonstration.

   H. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheets.

   D. Complete activities assigned by instructor.

   E. Take test.

## INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Overhead Camshaft Components

      2. TM 2--Drive Types

      3. TM 3--Tensioning Devices

D. Job sheets

1. Job Sheet #1--Remove, Inspect, and Install an Overhead Camshaft
2. Job Sheet #2--Adjust a Tensioning Device

E. Test

F. Answers to test

II. References:

A. *Chilton's Honda Singles Repair and Tune-Up Guide.* Philadelphia, Pennsylvania: Chilton Book Co., 1973.

B. *Honda GL1000 Service Manual.* Gardena, California: American Honda Motor Co., 1976.

C. *Motorcycle Service Manual.* Vol. 2. 3rd ed. Kansas City, Missouri: Technical Publications Division/Intertec Publishing Corp., 1972.

D. *Chilton's Motorcycle Repair Manual.* Radnor, Pennsylvania: Chilton Book Co., 1974.

# OVERHEAD CAMSHAFTS
## UNIT I

## INFORMATION SHEET

I. Terms and definitions

A. Overhead camshaft (OHC)--Valve arrangement where the camshaft is mounted in the top of the cylinder head or "overhead"

B. Tensioner--Device designed to eliminate excessive slack in the camshaft drive mechanism

II. Major components of the overhead camshaft system (Transparency 1)

A. Camshaft

B. Camshaft sprocket

C. Camshaft drive chain

D. Valves

E. Crankshaft sprocket

F. Rocker arms

G. Tensioner

(NOTE: Components listed are for chain type drive, which is the most common type used.)

III. Types of overhead camshaft drives (Transparency 2)

A. Chain

B. Gear

C. Belt

IV. Types of tensioners (Transparency 3)

A. Manual

(NOTE: The camshaft drive tension is adjusted by a technician and frequent adjustment is required.)

B. Automatic

(NOTE: The camshaft drive tension is adjusted by a preloaded spring pressure performed by a technician. This type of adjustment is required less frequently than the adjustment on manual types.)

## INFORMATION SHEET

V. Operation of the overhead camshaft system

   A. Camshaft mounted in cylinder head above valves

   B. Rocker arms operate in contact with camshaft

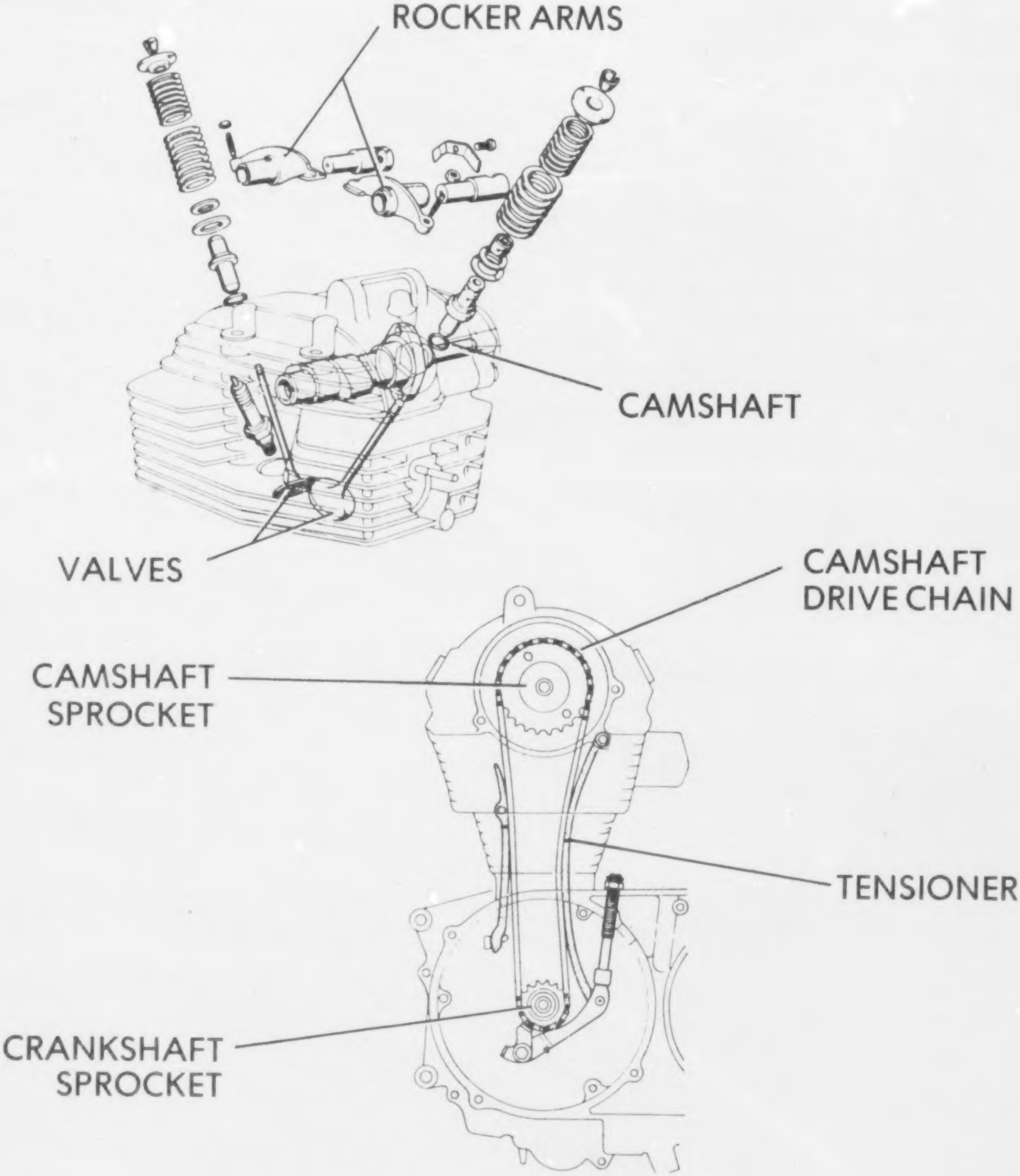
      1. Eliminates need for lifters and push rods

      2. Permits economical manufacture of a more efficient combustion chamber design

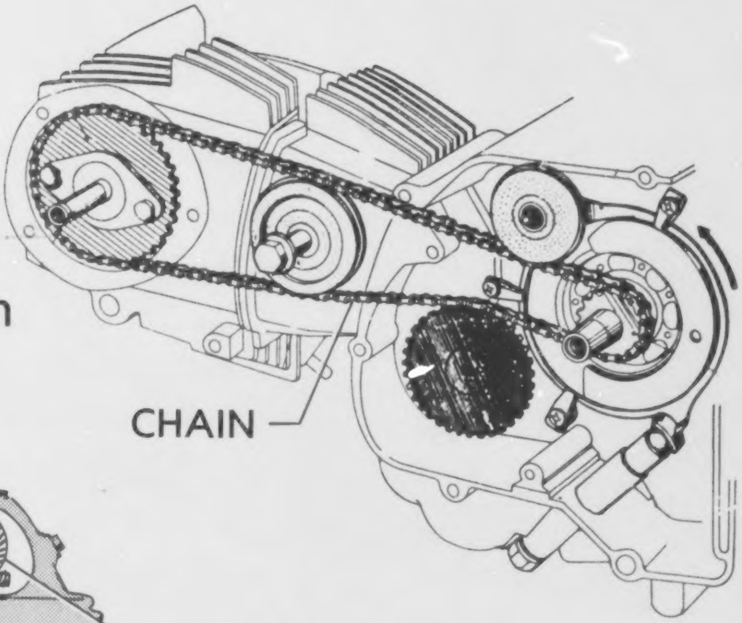
      3. Permits higher potential engine RPM

   C. Drive mechanism connects crankshaft to camshaft

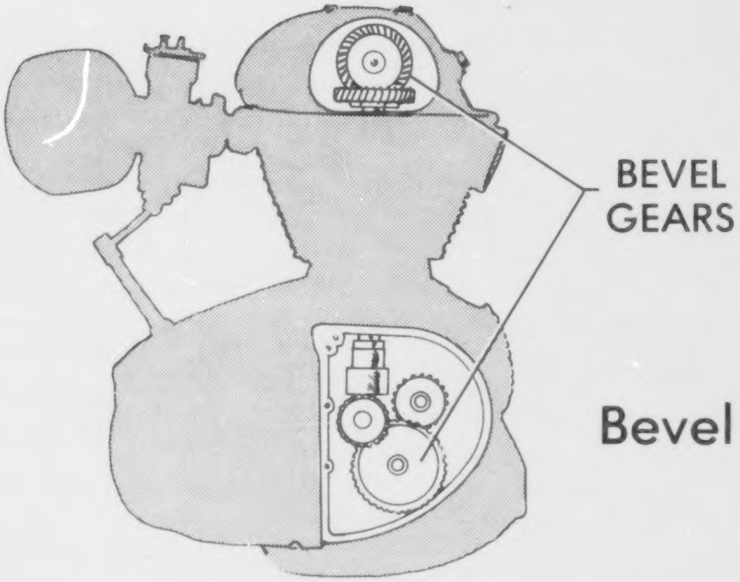
# OVERHEAD CAMSHAFT COMPONENTS


ROCKER ARMS
CAMSHAFT
VALVES
CAMSHAFT DRIVE CHAIN
CAMSHAFT SPROCKET
TENSIONER
CRANKSHAFT SPROCKET

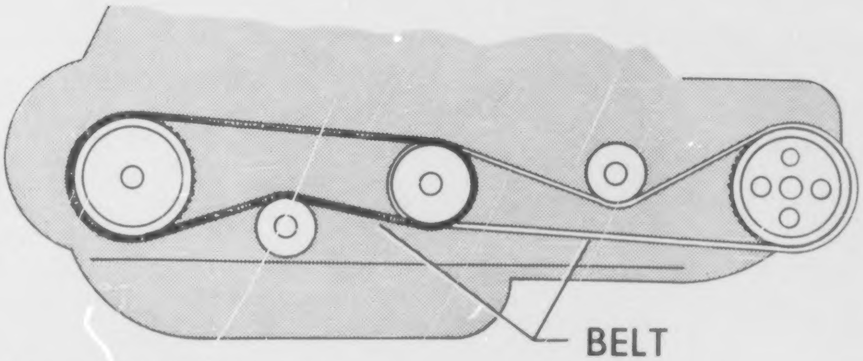
# DRIVE TYPES



**Chain**


BEVEL GEARS

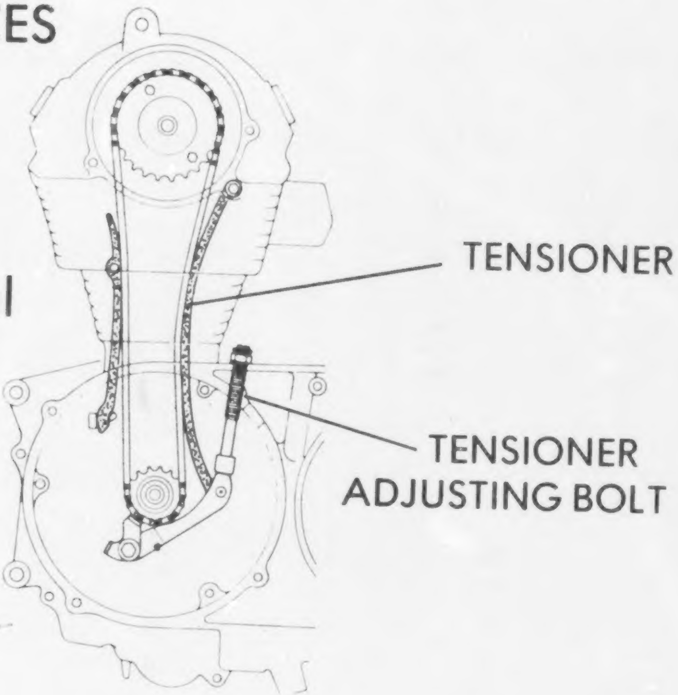
**Bevel**

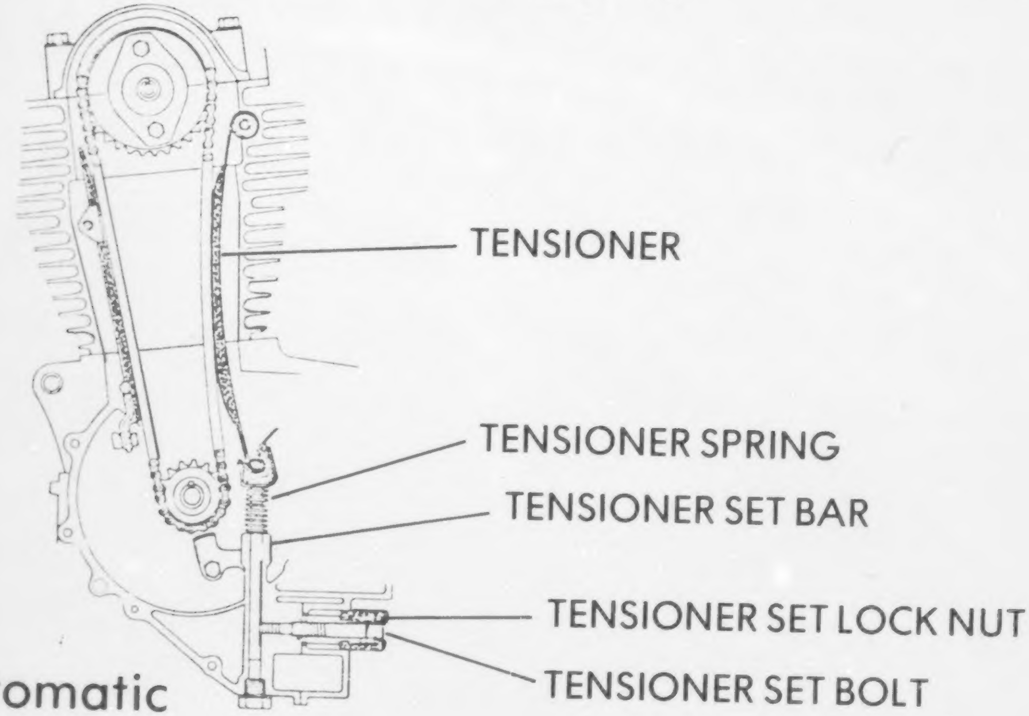


**Belt**

# TENSIONING DEVICES

Manual


TENSIONER
TENSIONER ADJUSTING BOLT


TENSIONER
TENSIONER SPRING
TENSIONER SET BAR
TENSIONER SET LOCK NUT
TENSIONER SET BOLT

Automatic

# OVERHEAD CAMSHAFTS
## UNIT I

## JOB SHEET #1 REMOVE, INSPECT, AND INSTALL AN OVERHEAD CAMSHAFT

I. Tools and materials

  A. Metric socket set

  B. Metric end wrench set

  C. Screwdriver assortment

  D. 0-1" inside micrometer

  E. 0-1" telescoping gauge

  F. 12" length of mechanics wire

  G. Appropriate service manual

  H. Honda CB100 motorcycle

  I. Impact driver

  J. Safety glasses

II. Procedure

(NOTE: The following procedure is for a Honda 100cc single cylinder engine. Consult appropriate service manual for other makes.)

  A. Remove alternator side cover

  B. Remove cylinder head side cover

  C. Remove breaker plate and advance mechanism

  D. Rotate engine so that camshaft timing marks line up

  E. Remove bolts securing camshaft sprocket

  F. Attach 12" length of mechanics wire to camshaft drive chain

  (NOTE: If the chain falls into the crankcase, the wire will help you pull it back up with a minimum of trouble.)

  G. Remove camshaft sprocket

## JOB SHEET #1

H. Pull camshaft from cylinder head (Figure 1)

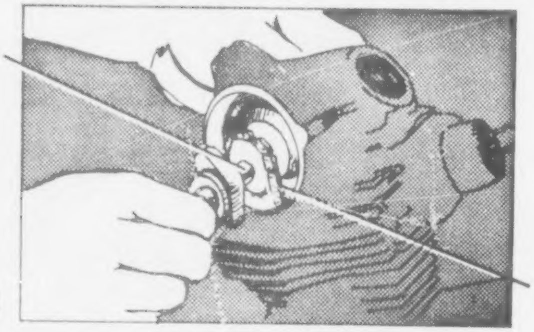

CAMSHAFT
CAM CHAIN

FIGURE 1

I. Measure camshaft bearing bore (Figure 2)

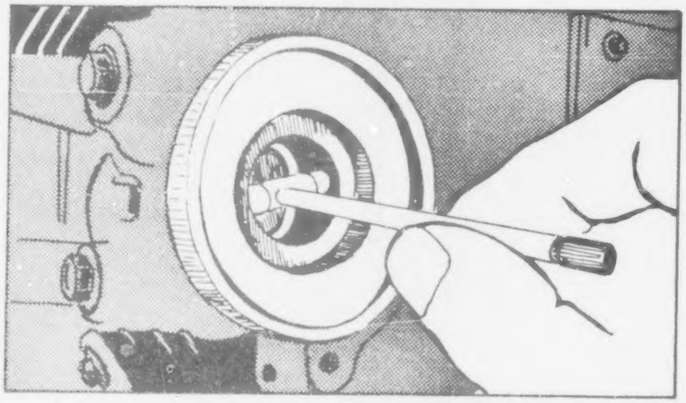


FIGURE 2

J. Measure camshaft bearing surfaces (Figure 3)

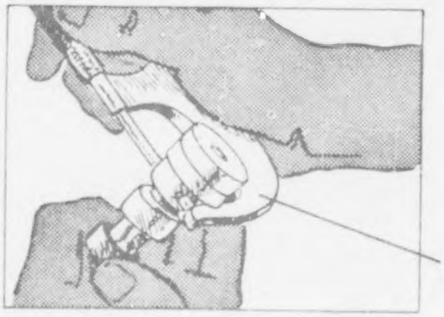
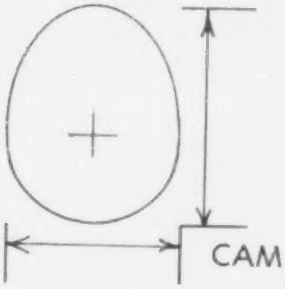

MICROMETER

FIGURE 3

## JOB SHEET #1

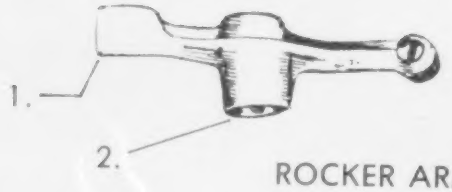
K. Measure cam lobes (Figure 4)



CAM LOBE MEASURING POINTS
FIGURE 4

L. Remove rocker arms

M. Inspect rocker arms for excessive wear (Figure 5)



ROCKER ARM WEAR POINTS
FIGURE 5

N. Install rocker arms

O. Install camshaft

(NOTE: Be careful not to damage bearing surfaces in cylinder head.)

P. Rotate camshaft into correct timing position

Q. Install camshaft sprocket and drive chain

R. Check timing mark alignment and install camshaft sprocket securing bolts

S. Install advance mechanism and breaker plate

T. Adjust ignition timing

U. Install cylinder head side cover

V. Install alternator side cover

# OVERHEAD CAMSHAFTS
# UNIT I

## JOB SHEET #2--ADJUST A TENSIONING DEVICE

I. Tools and materials

- A. Metric end wrench set
- B. Screwdriver assortment
- C. Appropriate service manual
- D. Motorcycle with OHC engine
- E. Safety glasses

II. Procedure

A. Adjust manual tensioner

1. Remove valve access covers
2. Rotate engine to TDC on compression stroke
3. Loosen camshaft drive tensioner adjustor locknut
4. Loosen adjustor screw to free tensioner
5. Tighten adjustor screw until there is a noticeable resistance on the screw

   (NOTE: Rotate screw counterclockwise to tighten adjustment.)
6. Secure locknut while holding the screw steady
7. Install valve access covers

B. Adjust automatic tensioner

1. Remove alternator rotor cover
2. Remove valve access covers
3. Rotate alternator rotor slowly in the normal direction of rotation until piston is TDC on compression stroke
4. Rotate alternator rotor against normal rotation 1/4 turn
5. Loosen camshaft drive tensioner locknut and bolt

   (NOTE: The slack in the drive will be taken up automatically by the tensioner spring.)

# JOB SHEET #2

6. Tighten adjustor bolt and secure locknut
7. Install valve access covers
8. Install alternator rotor cover

## OVERHEAD CAMSHAFTS
## UNIT I

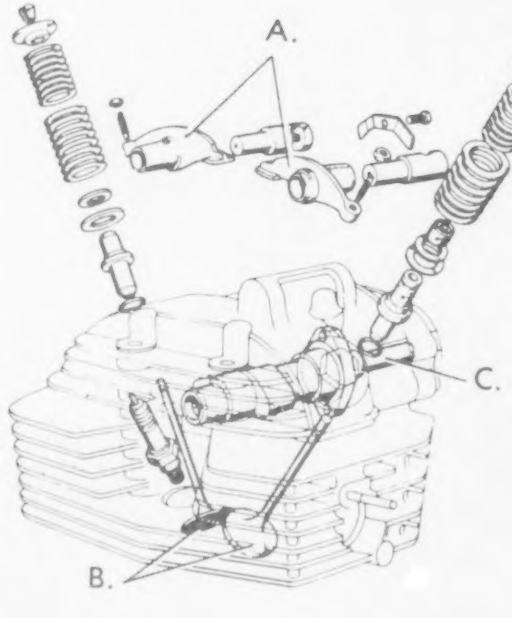
## TEST

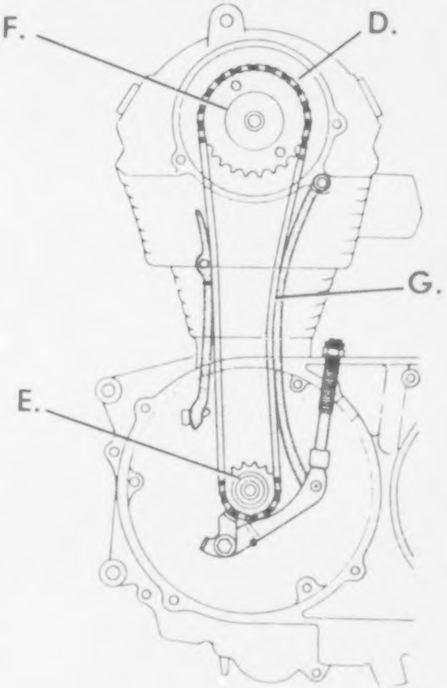
1. Define terms associated with overhead camshafts.

   a. Overhead camshaft (OHC)--

   b. Tensioner--

2. Identify the major components of the overhead camshaft system.





a. ____________ ____________

b. ____________ ____________

c. ____________ ____________

d. ____________ ____________

e. ____________ ____________

f. ____________ ____________

g. ____________ ____________

3. Select the types of overhead camshaft drives by placing an "X" in the appropriate blanks.

______a. Hydraulic

______b. Gear

______c. Direct

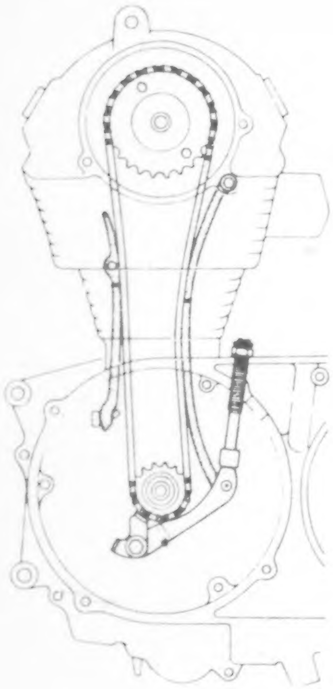
______d. Pneumatic

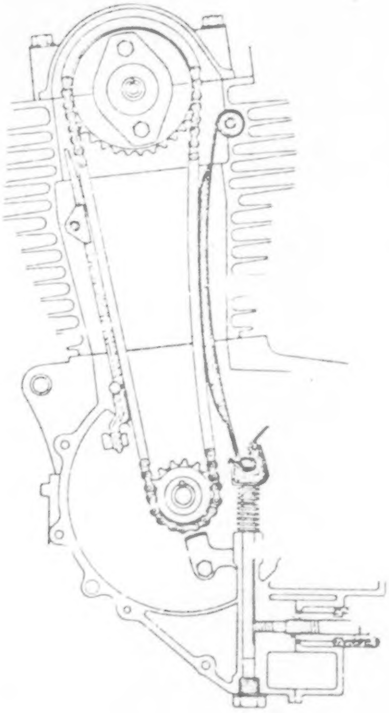
______e. Belt

______f. Automatic

______g. Chain

4. Identify the types of tensioners.





a. ____________ ____________ b. ____________ ____________

5. Discuss the operation of the overhead camshaft system.

6. Demonstrate the ability to:

   a. Remove, inspect, and reinstall an overhead camshaft.

   b. Adjust a tensioning device.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

# OVERHEAD CAMSHAFTS
## UNIT I

## ANSWERS TO TEST

1. a. Overhead camshaft (OHC)--Valve arrangement where the camshaft is mounted in the top of the cylinder head or "overhead"

   b. Tensioner--Device designed to eliminate excessive slack in the camshaft drive mechanism

2. a. Rocker arms

   b. Valves

   c. Camshaft

   d. Camshaft drive chain

   e. Crankshaft sprocket

   f. Camshaft sprocket

   g. Tensioner

3. b, e, g

4. a. Manual

   b. Automatic

5. Discussion should include:

   a. Camshaft mounted in cylinder head above valves

   b. Rocker arms operate in contact with camshaft

      1) Eliminates need for lifters and push rods

      2) Permits economical manufacture of a more efficient combustion chamber design

      3) Permits higher potential engine RPM

   c. Drive mechanism connects crankshaft to camshaft

6. Performance skills evaluated to the satisfaction of the instructor